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EVALUATION OF JUVENILE FISH BYPASS AND ADULT FISH PASSAGE FACILITIES AT THREE MILE FALLS DAM, UMATILLA RIVER

Annual Progress Report

October 1989

Edited by

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Oregon Department of Fish and Wildlife

Cooperators

Oregon Department of Fish and Wildlife
Confederated Tribes of the Umatilla Indian Reservations

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EXECUTIVE SUMMARY

We report on our progress from October 1989 through September 1990 on evaluating juvenile fish bypass and adult fish passage facilities at Three Mile Falls Dam on the Umatilla River. The study is a cooperative effort by the Oregon Department of Fish and Wildlife (ODFW) and the Confederated Tribes of the Umatilla Indian Reservation (CTUIR). Study objectives addressed by ODFW and CTUIR are

1. ODFW (Report A): Operate and evaluate the juvenile fish bypass system in the West Extension Irrigation District canal at Three Mile Falls Dam.

2. CTUIR (Report B): Examine the *passage* of adult salmonids at Three Mile Falls Dam.

The study is part of a program to rehabilitate anadromous fish stocks in the Umatilla River Basin that includes restorations of coho salmon *Oncorhynchus Wsutch* and chinook salmon 0. *tshawytscha* and enhancement of summer steelhead 0. *mykiss*.

Highlights of results of our work with the juvenile fish bypass facility at Three Mile Falls Dam *are*

1. We sampled several species of fish from the juvenile fish bypass facility in November 1989 and Spring 1990. In November 1989 we sampled 10 northern squawfish, 35 largescale suckers, 20 white crappie and 3 fall chinook. In Spring 1990 we sampled 22,565 fish; 23.1 percent were yearling chinook, 60.8 percent were subyearling chinook, 14.1 percent were coho and 2.0 percent were summer steelhead,. Our estimates of passage by Three Mile Falls Dam in Spring 1990, based on sampling rates, were 92,857 yearling chinook, 67,189 subyearling chinook, 56,222 coho and 2,662 summer steelhead.

2. Peak numbers of juvenile salmonids bypassed generally corresponded to peak flows. Two exceptions were yearling chinook and coho, their numbers peaked as flows were approaching lowest levels of the season. Majority of juvenile chinook migrated quickly out of the system. However, coho and. steelhead had protracted periods.

3. Mean descaling rates of juvenile salmon and steelhead ranged from 1.2 percent for fall chinook subyearlings to 7.7 percent for hatchery summer steelhead. These descaling rates were comparable to those observed at McNary Dam. Other injuries included bird predation marks, fungal infections, head bruises and body injuries.

4. Each group of hatchery and naturally produced juvenile salmonids had a distinct length frequency distribution. Hatchery coho and summer steelhead were generally smaller than their naturally produced counterparts.

5. The bypass outfall sampler effectively sampled all marked fish contained in the outfall. Five marked yearling chinook and two marked steelhead were not recovered because they remained in the bypass.

6. Approach and *sweeping* velocity measurements taken at West Extension Irrigation District canal drum **screens** 1, 2 and **3 were** lowest when canal flow was lowest. At drum screen 4 they did not vary with canal flow.

7. Some juvenile salmonids were found *in* the West Extension Irrigation District canal downstream from the drum screens. How fish got past the screens is unknown.

8. When flow was below 50 cfs and the head **works** elevation was less than 403.4 ft, outmigrating juvenile salmonids could not be bypassed or sampled because water could not flow over the inclined screen.

9. Flow through the bypass was obstructed by debris that got past the trash rack.

10. When sampling-trapping facilities were in place or river flow was low, bypass flow was less than 10 **cfs** and fish did not readily exit the system. Under these conditions, fish may become stranded in the system.

11. Juvenile salmonids were observed to use the east bank adult **salmonid** ladder to bypass Three Mile Falls Dam.

Highlights of results of our work with the adult fish passage facility at Three Mile Falls Dam are

1. We counted 4,623 **coho** (4,102 adults and 521 jacks), 1,668 **summer** steelhead, 602 fall chinook (279 adults, 247 jacks and 76 subjacks) and 2,188 spring chinook (2,156 adults and 32 jacks) at Three Mile Falls Dam in Fall 1989 and Spring 1990.

2. Migration periods of **coho** and fall chinook extended **from early** October through early January. Summer steelhead migrated from early October through early May. Spring chinook migrated from early April through June.

3. Flows during **coho** and fall chinook migration mostly ranged from 150 to 250 **cfs;** peak numbers **passed** Three Mile Falls Dam after freshet8 increased flows by 50 **cfs** increments and temperatures **increased by** 1.5 C. Most **summer** steelhead arrived at the dam in February and March; large numbers **were** counted after freshetm increased flows above 1000 cfs. Spring chinook numbers consistently increased dramatically each time flows exceeded 1000 **cfs.**

4. We sampled approximately 30 percent of migration days using **video**-recording equipment installed in the right bank adult passage facility viewing room of Three **Mile** Falls Dam. Video-tape images of adult salmonids passing the viewing window **were** clear during most flow and turbidity conditions.

5. Based on video-tape images, we counted 509 summer steelhead and 1,286 spring chinook past the *viewing* window in the right bank adult fish passage facility at Three Mile Falls Dam. These counts were the differences between individuals moving upstream past the window and

those dropping back downstream past the window. For summer steelhead, 2,435 individuals moved upstream and 1,926 dropped back downstream. For spring chinook, 7,912 moved upstream and 6,626 dropped back downstream. Summer steelhead moved primarily during early morning and early evening (dusk), whereas spring chinook moved during all daylight hours.

6. Concurrent counts of summer steelhead based on video-tape images and direct observations in the right bank trap were 375 and 392; video-tape counts were 96 percent of trap counts. Concurrent counts of spring chinook based on video-tape images and direct observations by observers at the viewing window were 1,124 and 926; trap counts were 79 percent of video-tape counts. Concurrent counts of all adult salmonids in the trap, the ladder and pools just downstream from the ladder showed comparable trends; when many fish were in the trap, many were also observed in the ladder and in pools just downstream from the ladder.

7. Counting video-tape images was labor intensive because frequent fallback of individuals required much examination and interpretation. We hypothesize that fallback may have been caused by fish holding in the viewing area while attempting to ascend the Denil steep pass to the trap. Flows at the Denil steep pass entrance may be inadequate to attract adult fish into the pass.

8. Carcass surveys conducted downstream from Three Mile Falls Dam counted 92 dead fall chinook (15 percent of the total trapped at the dam), 52 dead coho (1 percent of the total trapped at the dam) and 75 redds. It is unclear whether these fish spawned downstream from Three Mile Falls Dam because of passage problems at the dam.

REPORT A

1. Operation and evaluation of the juvenile fish bypass system in the West Extension Irrigation District Canal at Three Mile Falls Dam.

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We thank Steve Banghart of our staff for assisting with design and fabrication of sampling apparatuses and with the initial field sampling. We extend thanks to Tom Leonard, Tom Clover and Randy Wilsey of the U.S. Bureau of Reclamation for their commendable modification work at the bypass facility and for assistance in system operation. We also thank Jerry Franke and Richard Berg of the West Extension Irrigation District for their assistance and cooperation in system operation. We thank Jay Marcotte and Jerry Bauer of the Bonneville Power Administration for their assistance with contracting of funds.

We would like to thank Gerry Rowan of the Confederated Tribes of the Umatilla Indian Reservation for his assistance with field sampling and also Keith Kutchfns of the CTUIR for the use of equipment. We extend thanks to Greg Rupert of the U.S. Geological Survey and Steve Fanciullo of the U.S. Bureau of Reclamation for supplying daily flow information.

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ABSTRACT

We report on our effort from October 1989 through September 1990 to operate and evaluate the juvenile salmonid bypass facility in the West Extension Irrigation District Canal at Three Mile Falls Dam on the Umatilla River. After test operation of the facility during November 1989, numerous modifications to improve passage and sampling of juvenile salmonids were incorporated into the facility. During the juvenile salmonid outmigration of spring 1990 we evaluated the efficiency of the bypass facility, and collected data on the condition of fish bypassed. We also designed and tested a floating net pen to capture juvenile salmonids below the bypass outfall and measured approach and sweeping velocities at the drum screens in the canal. The bypaes facility usually operated satisfactorily, except during periods of extremely low flow. The floating net pen was efficient in capturing fish at the bypass Outfall. Velocities at the drum screens were usually within criteria for safe passage of juvenile salmonids. We Offer recommendations for improving the performance of the bypass facility, and also recommend that a detailed evaluation of the facilities, including evaluation of fish condition and fish passage through or over the drum screens, be conducted.

INTRODUCTION

Background

The Umatilla River historically supported runs of fall and spring chinook salmon *(Oncorhynchus tschwytscha)*, coho salmon *(O. kisutch)* and summer steelhead (*O. mykiss*). Since the early 1900's, overfishing, extensive irrigation, habitat degradation, and Columbia River hydroelectric projects have eliminated chinook and coho salmon populations and reduced the summer steelhead run to a fraction of its former size (Boyce 1986).

Restoration of salmon and enhancement of steelhead populations in the Umatilla River was given high priority by the Oregon Department of Fish and Wildlife (ODFW) and the Confederated Tribes of the Umatilla Indian Reservation (CTUIR). Rehabilitation projects to solve fishery problems include upstream and downstream passage improvements at diversion dams and irrigation canals, passage improvements in the river channel downstream from Three Mile Falls Dam, habitat improvements in headwater streams, and hatchery supplementation and reintroduction of fish (Boyce 1986). Because low flows are the chief limiting factor in salmonid production (Boyce 1986), a flow enhancement project was developed by the U.S. Bureau of Reclamation (USBR) to improve flows in the Umatilla River for anadromous fish (USBR 1985).

Since restoration projects began 10 years ago, improvement has been made in restoring populations of all anadromous fish species. Fall chinook and coho salmon adult returns have increased steadily to 279 and 4,000 fish in 1989. The success of the recent introduction of spring chinook salmon was demonstrated in 1990 by a return of over 2,100 adults. For the first time in more than 70 years, a sport fishing season for spring chinook salmon was opened. The summer steelhead population has remained stable between 2,000 and 3,400 fish since 1983, although run size declined slightly to less than 2,000 in 1989 (CTUIR 1990).

The Umatilla River has been extensively developed for irrigation. The largest development is the Umatilla Project which provides irrigation water for four irrigation districts: (1) West Extension, (2) Hermiston, (3) Westland, and (4) Stanfield. The five diversion dams associated with these districts include Three Mile Falls at river mile (RM) 3.0, Maxwell (RM 14.8), Westland (RM 27.3), Cold Springs (RM 29.2), and Stanfield (RM 32.3) (Figure 1). These five dams have limited upstream migration of adult salmonids, and have not met fish screening or bypass criteria for juvenile salmonid downstream migration.

The Northwest Power Planning Council's (NPPC) Columbia River Basin Fish and Wildlife Program (1987) calls for passage improvement projects at Umatilla River water diversions to be completed by 1991 (Section 1403, Measure 4.2). Under contract with the Bonneville Power Administration (BPA) and in cooperation with CTUIR and fish and wildlife agencies, USBR developed and implemented a program to improve fish passage problems at Umatilla River diversion dams. Improved passage facilities at Three Mile Falls Dam were the first to be constructued.

Construction of similar fish passage and protection facilities at 20 irrigation diversions in the Yakima River Basin, Washington, has also been

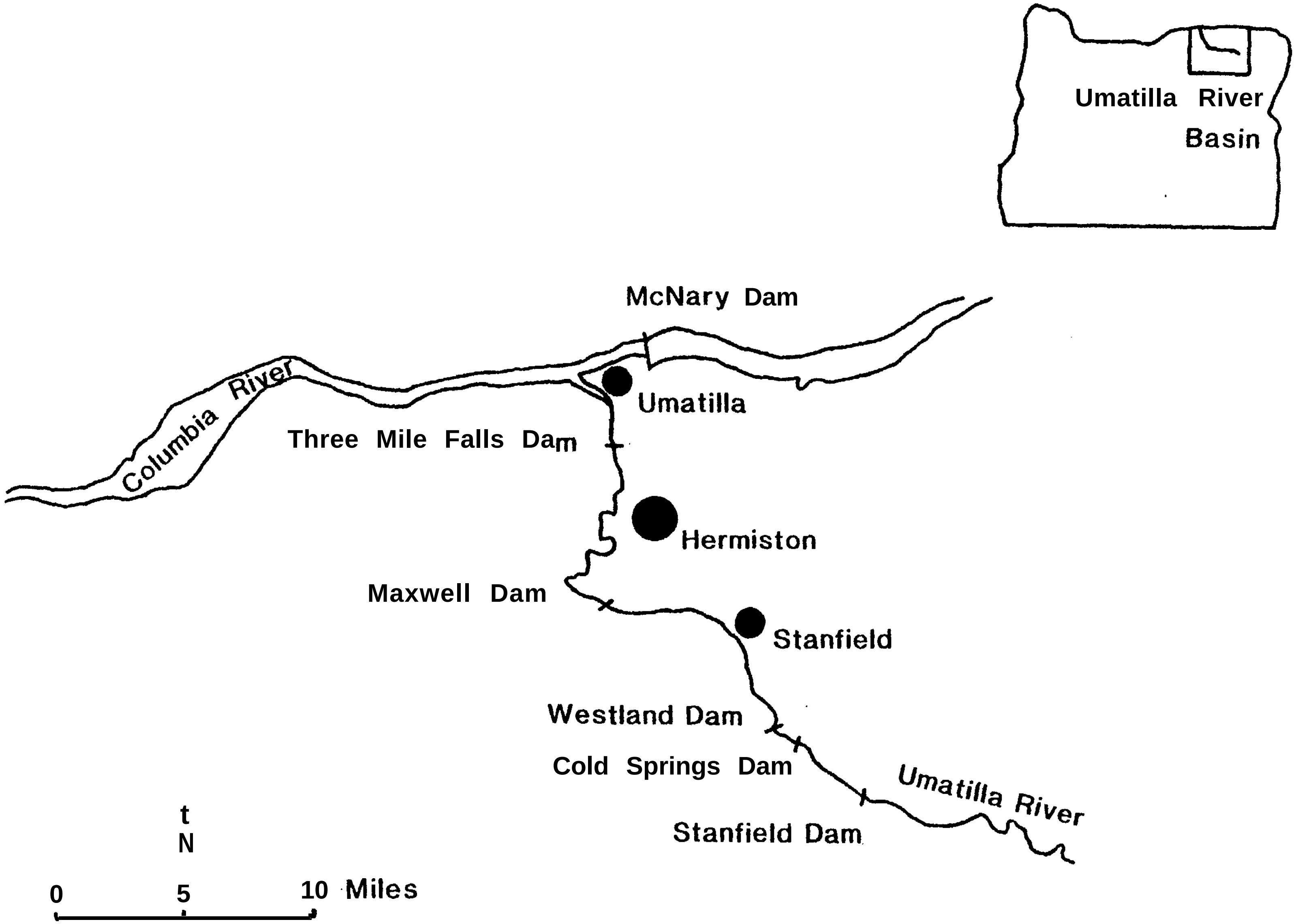

Figure 1. Locations of diversion dams on the lower Umatilla River, Oregon.

funded by BPA and USBR under Section 803, Measure (b) of the Columbia River Basin Fish and Wildlife Program (NPPC 1987). Evaluations of the effectiveness of these fish screening facilities on the Yakima River have been carried out by Neitzel et al. (1985, 1987, 1988) and Hosey & Associates (1988, 1989, 1990). We considered their experiences when designing evaluations of fish screening facilities in the Umatilla River basin.

Evaluation of the passage improvement project at Three Mile Falls Dam was euggested in *A Comprehensive Plan for Rehabilitation of Anadromous Fish Stocks in the Umatilla River Basin* developed by ODFW (Boyce 1986) in cooperation with CTUIR, and other fish and wildlife agencies. The first phase of the evaluation was conducted from October 1989 through September 1990 to become familiar with the passage improvements and test operate the bypass facility. The study objective was to operate and evaluate the juvenile bypass system in the West Extension Irrigation District (WEID) canal at Three Mile Falls Dam. This involved (1) ensuring the efficient operation of the bypass facility and that it operated as designed, and (2) developing a system to collect juvenile salmonids at the bypass outfall.

Study Site

Three Mile Falls Dam is the highest dam on the Umatilla River with a crest height of 24 ft and crest length of 915 ft. The dam was constructed by USBR in 1914 as part of the Umatilla Project. The water diversion was formerly screened by a louver system consisting of a 30 ft by 10 ft grate with a series of fixed metal slats spaced 1-2 in apart. An 8-in vertical bypass slot led to an 18-in bypass pipe that dropped fish 18 ft into the tailrace pool. Juvenile salmonids also passed over the crest of the dam. The drop of fish over the dam or through the bypass may have resulted in significant injury and mortality. Problems with approach and bypass slot velocities, and nonlaminar flows limited passage efficiency (Boyce 1986).

Construction of new fish passage facilities at Three Mile Falls Dam was completed in 1988 and included reconstruction of the east and west bank fish ladders to improve adult upstream migration, construction of adult fish trapping and viewing facilities, and installation of drum screens, a juvenile fish bypass and a juvenile fish trapping and passage evaluation facility in the WEID canal. The new screen and bypass facility in the canal was constructed to replace the louvre system and designed to comply with screening criteria necessary for safe passage of juvenile salmonids at all flows (Washington Department of Fisheries 1989).

The purpose of the canal screening system is to prevent juvenile fish from entering the WEID canal. All fish that attempt to enter the canal are screened and either diverted into the juvenile fish passage evaluation facilities, returned directly to the river, or trapped for transport. The canal screening system includes the canal trashrack structure, the headgates, the three-cell box culvert and flume section with guide walls, the drum screen structure, the juvenile fish trapping and passage evaluation facility, the 24-in diameter fish return pipe, the bypass outfall, the check structure, and the drainage system (Figure 2).

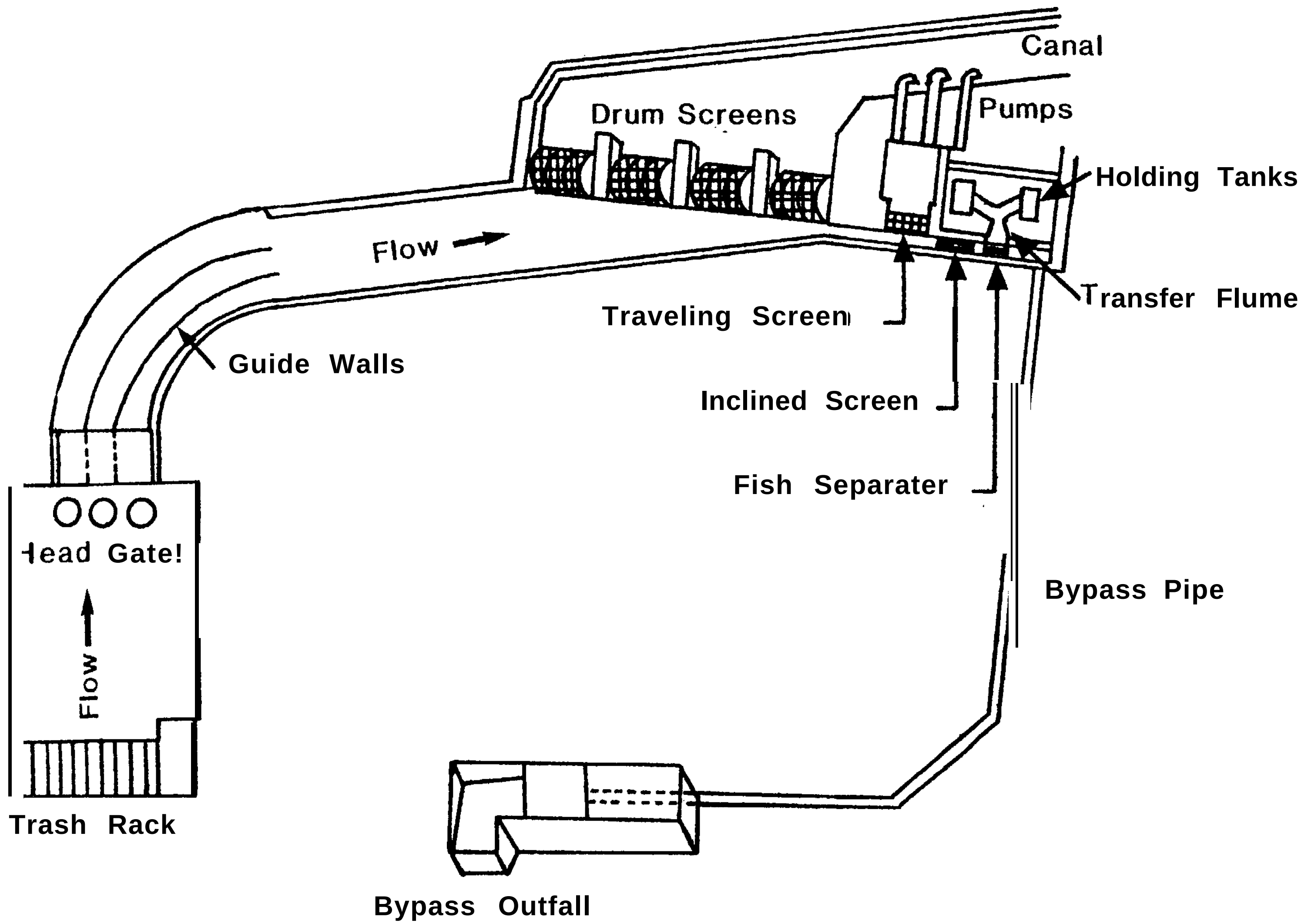

Figure 2. Schematic of the juvenile bypass facility at Three Mile Falls Dam.

The purpose of the trashrack is to prevent debris that could damage the drumscreens from entering the canal. The concrete guide walls downstream from the three-cell box culvert were designed to provide uniform flow across the flume section coming into the drum screens. The four rotary drum screens prevent juvenile fish from entering the WEID canal and direct these fish to the bypass channel. The check structure with steel slide gates is used to maintain the operating water surface at the drum screen structure, and to control the flow in the WEID canal. The drainage system drains off excess water left in the flume after canal dewatering (USBR 1989).

The juvenile fish trapping and passage evaluation facility operates in a variety of modes to handle the bypass flow and juvenile fish in accordance with the mode of operation specified (**APPENDIX A**). The facility includes two primary pumpback pumps which return 20 cubic feet per second (cfs) of bypass water to the canal, a traveling water screen which prevents juveniles from entering the pumpback flow and associated spray water pump that cleans the screen of debris, a fish bypass channel and downwell, an inclined screen and fish separator, and a transfer flume that carries fish to holding tanks. The inclined screen and fish separator are installed in the bypass channel during sampling or trapping operations to route fish into the sampling-trapping area. The transfer flume includes an adjustable gate designed to direct fish into the holding tanks and a timer that adjusts the gate position at desired intervals. The sampling-trapping work area houses two holding tanks and a work table, a secondary pumpback pump (5 cfs) that pumps tank overflow water into the canal, and the secondary pump sump and wasteway. The fish return pipe begins at the lower end of the bypass channel and terminates at the bypass outfall (Figure 2).

A gantry crane shared with the drum screen structure is used to remove the traveling water screen, fish separator and inclined screen, and to raise and lower the holding tanks. A 5 cfs restrictive orifice plate is placed in the bypass channel immediately downstream from the traveling water screen during low flows or when sampling or trapping fish (USBR 1989).

METHODS

Pre-Operation Activities

Bypass Facility

In November 1989, drum screens were put in place, stop logs were removed, and the juvenile salmonid bypass facility was operated for one week to collect late outmigrating juvenile salmonids. All fish were collected in one of two holding tanks provided for trapping and hauling of downstream migrating salmonids.

Observation of the trapping operation and inspection of the bypass facility revealed the need for improvement to and further testing of the bypass facility. Major modifications to the facility were made by USBR. We designed and fabricated minor modifications. Modifications to the bypass facility were designed to: (1) concurrently trap and hold and bypass fish, (2) access, retrieve, anesthetize and examine fish we sample, (3) provide auxiliary inflow water (or aeration system) for supplemental oxygen supply to both tanks, (4) recover and release fish, and (5) regulate tank water levels.

Modifications were completed during February and March 1990. USBR maintenance personnel refined the original modifications and designed an effective sampling system that one person can operate; we anticipate little need of future revamping. Specific modifications were:

(1) A fish crowder, lift basket and perforated divider were installed in the south (sampling) tank to ease holding and retrieval of fish. Fish could then be crowded into one-half of the tank, and the divider lowered to isolate them from new fish entering the tank. The lift basket raised the isolated fish to where they were easily accessed. Hinged and stationary mylar mesh covers were installed over the sampling tank to prevent escape of fish.

(2) Release and removal of fish from the north (recovery) tank were improved by removing the elbowed drain pipe and flanging the remaining drain stem onto an elongated 6-in plastic pipe. Also, one end of the steel wire tank cover was cut out and an aluminum slide gate was inserted to allow access into the tank.

(3) Similar modifications made to the recovery and sampling tanks included the installation of slide gates over the overflow slots to regulate water level in the tanks. In addition, overflow water was contained and routed into the primary drain line. Extended handles were placed on the drain slide gates to facilitate operation.

(4) To examine fish, a 6-in (depth) by 8-in (width) by 3-ft (length) anesthetic trough was fabricated. A transport trough, constructed of 6-in plastic pipe with the top half cut out, was positioned directly above the examining table and anesthetic trough. Auxiliary water was supplied to the trough to carry fish to the recovery tank.

(5) To supply auxiliary water, a 4-in metal pipe was tapped and flanged into the facility east wall in an area below the inclined screen. This location provided sufficient head pressure during normal water levels for good inflow of water. From the main pipe, 2-in lines were plumbed into the terminal ends of the fish transfer flumes for constant inflow into the tanks. A 1-in line supplied auxiliary water to the transport trough.

(6) Fish not sampled were bypassed. To accomplish this, a 5-in by 18-in bottom section was removed from the transfer flume leading to the north tank. A collection hopper with attached 6-in plastic pipe routed fish passing through the opening into the bypass downwell. A levered cover plate permited closure of the slotted opening to pass fish into the recovery tank, if needed. Deflectors were welded into the side of the transfer flume upstream of the opening to better channel fish and water into the hopper. Three surface sections of the pipe were removed and the openings were outfitted with handled covers to allow access into the pipe for inspection and removal of debris.

(7) To provide necessary oxygen to fish in the event inflow water was not sufficient, an aeration system to each tank was recommended. The initial step taken toward this modification was the relocation of the compressed air solenoid to allow for a dual air line supply (one to the tanks and one to the

sampling gate). Further work was discontinued until the need for an aeration system to the tanks was demonstrated.

(8) To facilitate operation of the sampling gate, remote control capabilities were provided in the sampling-trapping area.

The canal headworks area and juvenile fish passage evaluation-pumpback facility was watered-up from 7 March to 12 March 1990 to check the effectiveness of the modifications on the sampling and bypass operation. This was done with the restrictive orifice, inclined screen, and fish separator in place. The modifications proved effective and we noted only minor additional needs. We observed approximately 50 dead juvenile salmonids flushed out from the bypass which apparently had become stranded.

Bypass Outfall Sampler

The second major component of our pre-operation activities was the design and fabrication of a bypass outfall sampler. Requirements of the sampler were to: 1) capture the majority of fish bypassed at 5 and 25 cfs, 2) provide sanctuary for captured fish, 3) withstand turbulent river conditions and up to 25 cfs bypass discharge, 4) be easily deployed and retrieved, and (5) allow easy retrieval of fish.

We used a floating net pen design for the sampler. The net was attached to a top frame of 2.5-in plastic pipe measuring 6 ft by 6 ft 8 in and consisted of an inner 3/16-in mesh reinforced by an outer 5/16-in mesh of knotless nylon. The net was 11-ft deep and flared to a width of 10 ft on all sides at the weighted bottom. Steel rings to attach rope for positioning and securing the net were installed at each of the bottom four corners and on the top frame. A bottom net frame was originally included but subsequently removed because it proved cumbersome when deploying and retrieving the sampler.

System Operation

Bypass Facility

We started sampling the juvenile fish outmigration at Three Mile Falls Dam on 22 March 1990, one day after the WEID canal was watered up. The system was continually adjusted by repositioning the weir gate, inclined screen, and fish separator as water levels fluctuated in the headworks area. However, two major problems soon arose: (1) water was not sufficiently eliminated through the bypass pipe and subsequently backed up into the juvenile fish sampling-trapping area; this necessitated using alternative river return pipes to eliminate the water, and (2) juveniles were observed holding up in the headworks area of the canal in large numbers and not moving through the bypass.

To correct the latter problem, we increased the flow into the bypass by operating both pumpback pumps and the traveling screen and removing the restrictive orifice. Although this strategy increased fish movement slightly, the removal of the restrictive orifice created additional flow regulation problems in the juvenile fish sampling-trapping area. Therefore, the restrictive orifice was reinserted. By 2 April, large numbers of fish were moving out of the headworks area and entering the bypass on their own.

We suspected water was not adequately eliminated through the bypass because of a blockage somewhere in the 24-in fish return pipe. Consequently, on 30 March the bypass system was dewatered for pipe inspection. A large debris plug was located at the lower end of the pipe. An inside gap between two adjoining pipes, connected by an outside coupler, caused debris to wedge and accumulate. Approximately 1,000 live and dead juvenile salmonids were trapped behind the blockage and subsequently removed. Once the pipe was cleared of debris, water passage through the system returned to normal.

We sampled outmigrating juveniles until 15 June when low river flow precluded operation of the fish bypass and sampling-trapping facility. Occasional low flows briefly halted sampling operations. The sampling rate was usually set at 5% to 20%, but we occasionally sampled at rates as low as 3.5% or as high as 100%. The sampling gate timer was periodically checked for accuracy. We usually sampled for 24 hours, 4 days per week.

When possible, we collected data daily on fish bypass numbers, species composition, and fork length (mm) and condition of each fish sampled. We calculated daily bypass numbers as

$$N = n/(r \cdot (h/24))$$

where

N = Estimated number of fish bypassed,
n = Number of fish sampled,
r = Sampling rate (percentage of time sampled divided by 100), and
h = Number of hours sampled.

Fish condition was determined using descaling criteria developed by the U.S. Army Corps of Engineers (USACE) (Neitzel et al. 1985). Condition was based on the percentage of scale loss in each of five designated sections per side of fish and ranged from "good" (scale loss ≤ 3% per section) to "descaled" (cumulative scale loss ≥ 40% in any two sections). A fish was partially descaled if scale loss was > 3% but < 40% per section (Neitzel et al. 1985). For comparative purposes, summer steelhead were separated into hatchery and native stocks.

We obtained provisional flow data for the Umatilla River at RM 2.1 from the U.S. Geological Survey and USBR. Flow was estimated from the amount of spill over the dam on days when flow data was not available.

Bypass Outfall Sampler

The outfall sampler was tested twice. We deployed the sampler by placing it in the water and positioning it under the outfall, with ropes attached to 3 top frame side bridles and bottom net rings angled and anchored in different directions. During the first test on 25 April 1990, deployment and retrieval were difficult due to the cumbersome bottom frame. We then removed the bottom frame from the net bag and deployed the sampler again. Without the bottom frame, the river and outfall current billowed out the bag, providing sanctuary, and the sampler was less cumbersome to handle.

We conducted a second test of the sampler on 10 May. After positioning the net under the outfall, we released 37 marked juvenile salmonids in the bypass 2 ft upstream of the outfall. The net was left in place for 5 minutes following release of the fish. We then retrieved the net and examined fish for condition and to determine net efficiency. Both tests were conducted with bypass discharge less than 10 cfs.

Velocity Measurements

We measured approach and sweep velocities at the drum screens on 26 April, 9 May, and 10 May 1990. We used a Marsh McBirney electromagnetic flowmeter and recorded velocities (feet per second) at 0.2, 0.5, and 0.8 percent of water depth. Measurements were taken close to the drum screens and usually at the centerline perimeter of the screen. The probe was positioned parallel to the screen pointing upstream for recording sweeping velocities and pointed perpendicularly away from the screen for approach velocities. Current velocities were also measured at similar water depths at the bypass channel entrance. Headworks elevation, canal flow and operating conditions, water depth, and screen submerged depth were noted.

RESULTS

Bypass Facility

Species and numbers of juvenile fish collected during the one week operation of the bypass facility in November 1989 were: northern squawfish *Ptychocheilus oregonensis* (10), largescale sucker *Catostomus macrocheilus* (35), white crappie *Pomoxis annularis* (20), and fall chinook salmon (3).

Salmonids collected during the spring outmigration included spring (yearling) and fall (subyearling and yearling) chinook salmon, coho salmon, and summer steelhead. The number of fish bypassed, date when peak numbers bypassed, and outmigration period varied among species and stocks (Figure 3). We sampled 22,565 salmonid juveniles comprised of 23.1% yearling chinook salmon, 60.8% subyearling chinook salmon, 14.1% coho salmon, and 2.0% summer steelhead. In early June, naturally produced coho salmon fry and fingerlings were identified in the sample. Estimated numbers of each species bypassed during sampling operations were: yearling chinook salmon 92,857, subyearling chinook salmon 67,189, coho salmon 56,222, and summer steelhead 2,662.

Peaks in numbers of fish bypassed did not always correspond with peak flows (Figure 3). The largest peak in yearling chinook and coho salmon numbers occurred when flows were dropping to the lowest level of the season (mid-April). A shut down in bypass operations when flows dropped to less than 40 cfs from 19 April to 22 April stranded large numbers of fish in the headworks area. As flows increased and reached a peak on 3 May, fish numbers, especially coho salmon, remained relatively high. The peaks in numbers of subyearling fall chinook salmon and juvenile summer steelhead occurred when flows were unusually high during late May (> 1000 cfs) and early June.

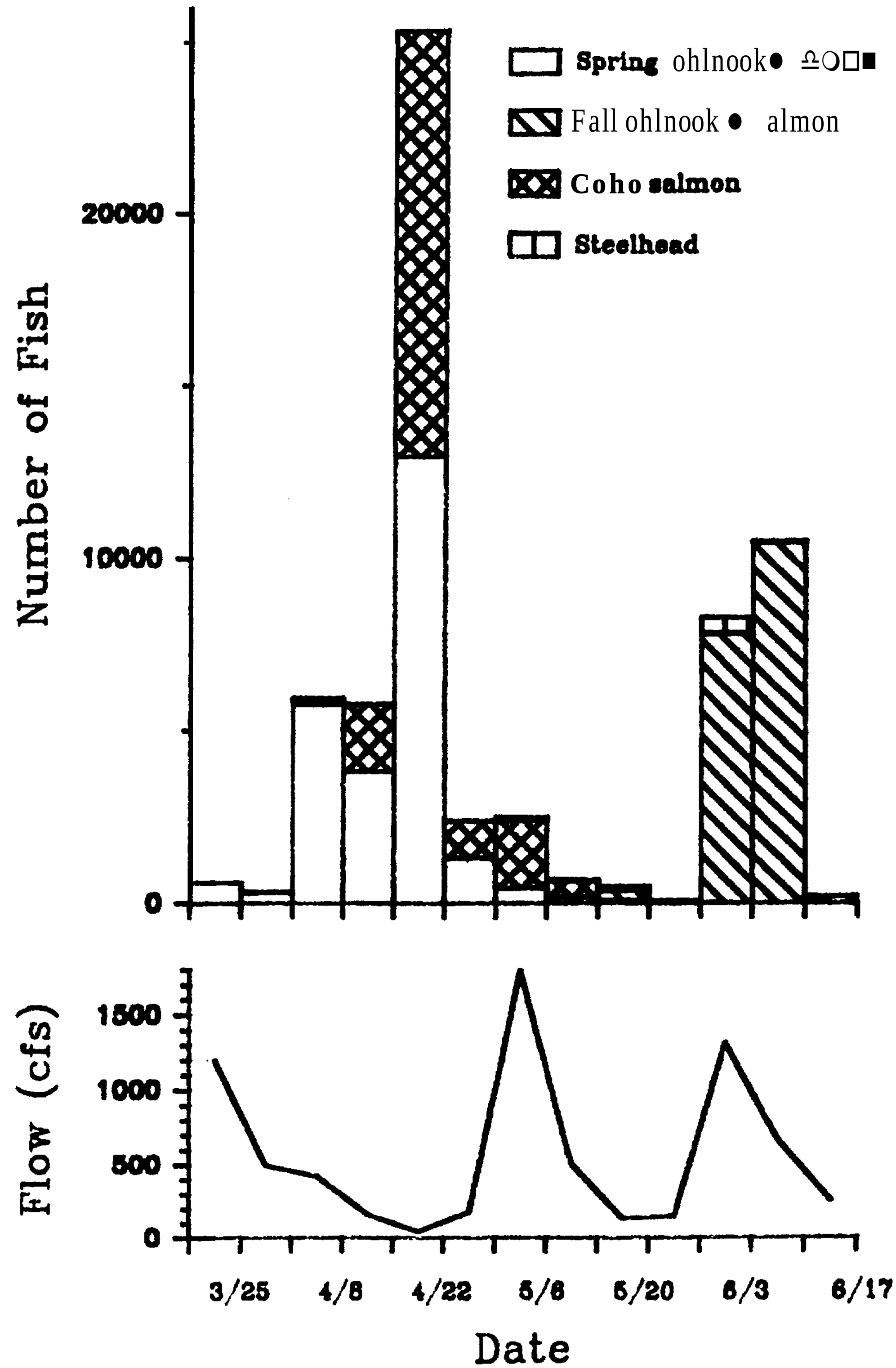

Figure 3. Weekly totals of the mean numbers of juvenile salmonids migrating through the bypass facility at Three Mile Falls Dam for each day sampled, and weekly summary of mean daily flow in the Umatilla River near Umatilla, Oregon.

The outmigration period also varied among species and stocks (Figure 3). The majority of fish releases were made above RM 60. The majority of yearling and subyearling chinook salmon migrated through the system relatively quickly after release, given no low flow periods. Coho salmon exhibited a protracted outmigration from late March to early June, although the bulk of the releases were made in late March to early April. Native summer steelhead also had an extended outmigration from late March to mid-June. Peak numbers of hatchery summer steelhead arrived almost 3 weeks after their release.

Fish condition varied temporally and among species (Figure 4). Condition of coho salmon, native summer steelhead and subyearling fall chinook was better at the beginning of their outmigration than at the end. First arrivals of hatchery summer steelhead were more descaled and in poorer condition than later arrivals. Mean descaling rate of hatchery steelhead was highest (7.7%), followed by coho salmon (5.9%), spring chinook salmon (3.8%), native summer steelhead (3.8%) and subyearling fall chinook salmon (1.2%). Juveniles also exhibited bird predation marks, fungal infections, head bruises, and body injuries.

Size range of fish varied among species and stocks (Figure 5). Native summer steelhead and naturally produced coho salmon were smaller than their hatchery counterparts.

Bypass Outfall Sampler

During the second test of the outfall sampler, we recovered all marked subyearling chinook (18) and coho (9) salmon, but only 2 of 7 marked yearling chinook salmon and 1 of 3 marked steelhead. Because no fish were observed to escape the sampler, we assumed the uncollected fish swam back up into the bypass channel. One coho and one yearling chinook salmon were descaled. All other fish were in good condition.

Velocity Measurements

Approach and sweeping velocity measurements taken at the WEID canal drum screens varied with canal flow and operating conditions (Table 1). Approach and sweeping velocities at drum screens 1 through 3 were lowest on 26 April when canal flow was low and the pumpback pumps were operating. We also took the readings closer to the downsteam end of the screens on this date. Velocities differed little between 9 and 10 May, as did operating conditions and canal flow. Sweeping velocities usually at least doubled approach velocities. Pockets of extremely low approach velocities were recorded on all three dates. Water velocity through the bypass channel entrance averaged 0.51 feet per second.

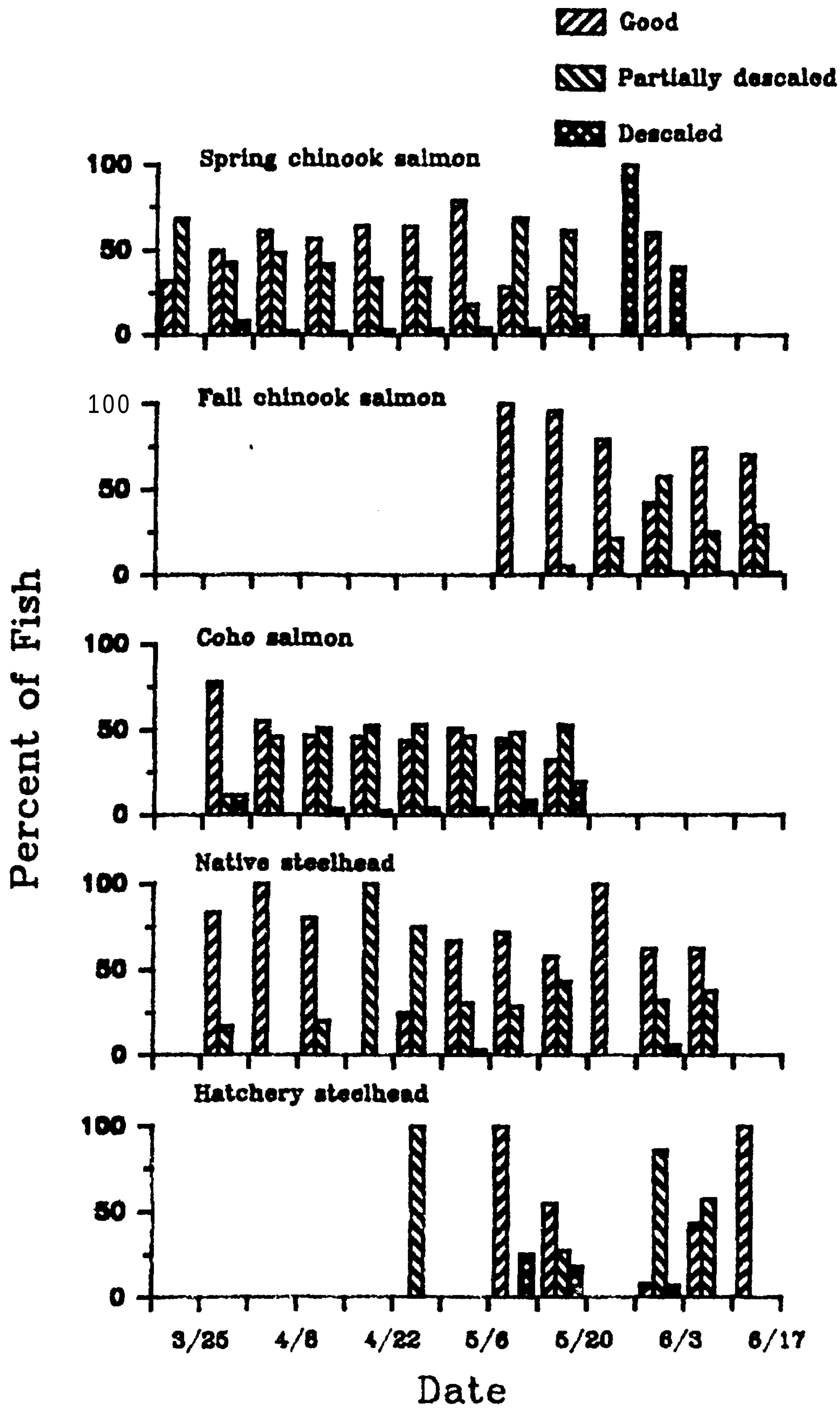

Figure 4. Condition of juvenile salmonids collected in the bypass at Three Mile Falls Dam, summarized by week.

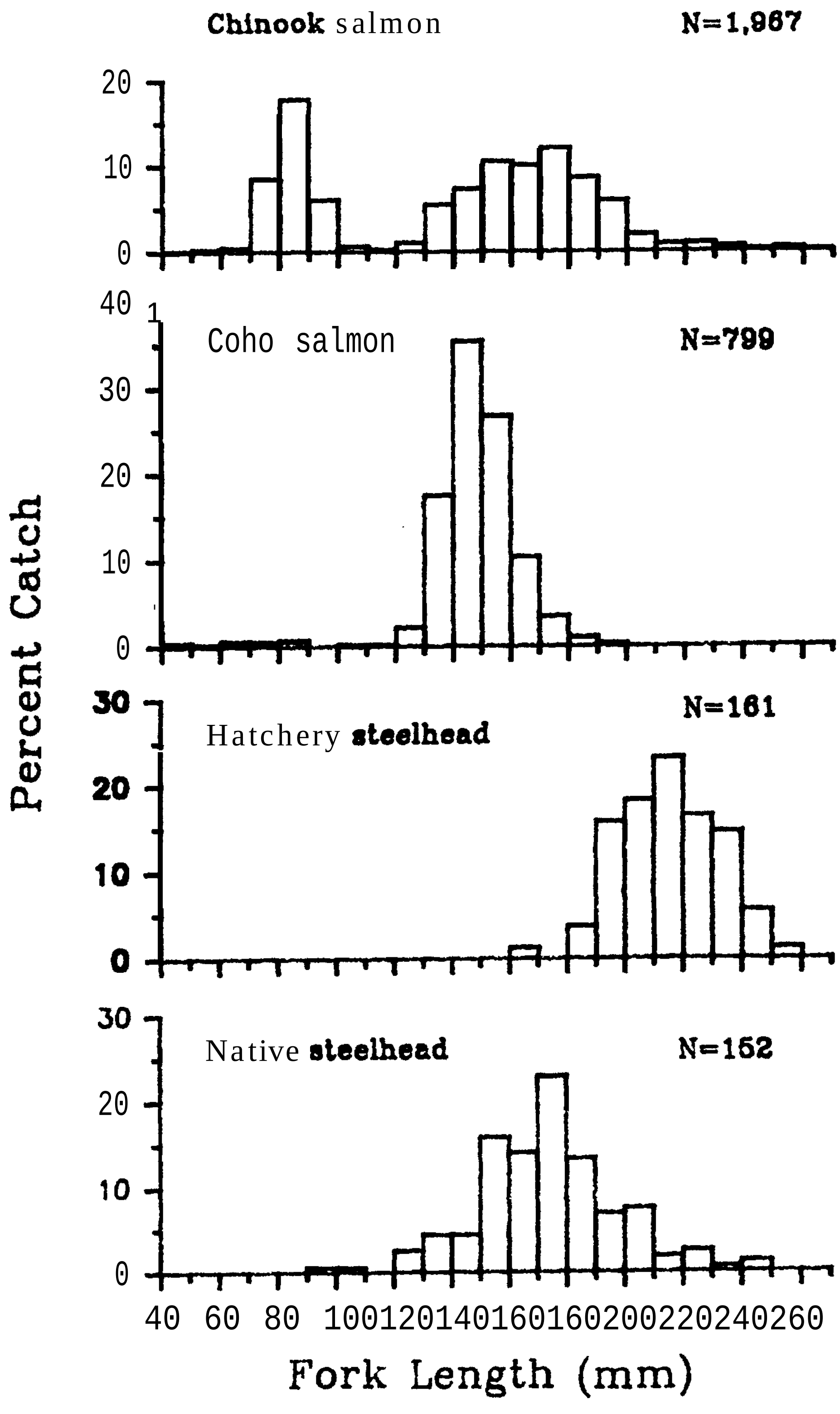

Figure 5. Length-frequency distributions of juvenile salmonids collected in the bypass at Three Mile Falls Dam.

Table 1. Approach and sweep velocity measurements (cfs) at the West Extension Irrigation District Canal drum screens. Canal flow was 50 cfs on April 26, and 128 cfs on May 9 and May 10. Pumpback pumps were operating on April 26 only. Surface water elevation was 404.1 ft each day.

Drum screen, percent depth	Velocity by date					
	April 26		May 9		May 10	
	Approach	Sweep	Approach	Sweep	Approach	Sweep
Number 1:						
20	0.09	0.25	0.05	0.96	0.06	0.88
50	--	--	0.04	0.85	0.32	0.99
80	0.12	0.35	0.48	--	0.53	0.98
Number 2:						
20	0.05	0.35	0.35	0.86	0.52	1.00
50	--	--	0.24	0.97	0.33	1.02
80	0.07	0.33	0.55	--	0.52	0.96
Number 3:						
20	0.12	0.45	0.30	0.88	0.20	0.88
50	--	--	0.13	0.80	0.22	0.97
80	0.22	0.50	0.50	--	0.52	1.12
Number 4:						
20	0.66	0.96	0.13	0.93	0.08	0.74
50	--	--	0.30	0.86	0.46	1.00
80	0.28	0.85	0.22	--	0.35	0.95

DISCUSSION

The first major peak in subyearling chinook salmon and summer steelhead numbers occurred the day following termination of CTUIR juvenile salmonid trap and haul operations at Westland Dam (29 May). Fish numbers were very low at Three Mile Falls Dam during late May because most fish were intercepted at Westland Dam. Upriver juvenile salmonid trap and haul operations may also be the reason why fish numbers were low at Three Mile Dam in late April, although many fish remained in the lower river and came through in good numbers when river flows increased.

Differences in length of the outmigration among species may be caused by differences in behavior. Fish behavior is an important consideration when evaluating effectiveness of bypass facility operation. The short travel time for chinook salmon and delayed arrival of summer steelhead may be reflected in travel time through the bypass facility. Travel time through the facility will be verified by conducting future controlled experiments.

Descaling rates of hatchery steelhead, coho salmon and subyearling chinook salmon were comparable to rates at nearby McNary Dam on the Columbia River (USACE 1988, 1989). The descaling rate for yearling chinook salmon in the Umatilla River was lower than that reported at McNary Dam (USACE 1988, 1989). Supplementing the small data set for hatchery and native summer steelhead with future sampling will validate the descaling results for these species. River conditions, length of travel, and release location may have affected fish condition.

The delay in fish movement in the headworks area during initial operation remains an enigma. It is possible the fish were holding up because of insufficient flows and water draw in this particular area because canal flow was low (49 cfs) and headgates were minimally opened. Another reason for the delay may have been that few fish had completed smoltification; the behavioral urge to migrate may not have been strong enough to pass these fish through a relatively calm system. An increased migrational urge with advanced smoltification and increased canal flow may have been the stimuli for active movement through the system.

Throughout the early part of the sampling season some juvenile salmonids were not diverted into the fish sampling-trapping area because they escaped off the end of the 3-ft separator (1-in bar gap) into the bypass downwell. Fish coming in too fast or at a perpendicular orientation to the bars were most prone to avoiding diversion into the sampling-trapping area. We observed approximately 10% of the fish exiting off the separator into the downwell. We did not use a separator bar assembly with a larger gap (1 and 1/2 in) because of the need to exclude larger fish and debris. In late April, USBR installed a 2-in neoprene barrier at the downstream end of the separator which considerably reduced escape of juvenile salmonids yet allowed the escape of nonseparated fish.

The bypass outfall sampler captured the majority of fish bypassed at low flows (< 10 cfs), provided sanctuary for captured fish, and allowed relatively easy and unstressful retrieval of fish. Sampler deployment and retrieval were moderately difficult, requiring at least 4 people. Because we were unable to test the sampler when bypass water was 25 cfs or river conditions were turbulent, it is unknown whether the sampler can withstand high bypass and river flows and also capture the majority of fish. Minor modifications will be made to fasten the net bag more securely onto the top frame.

Results from velocity measurements indicate that approach and sweeping velocities at the drum screens met criteria for juvenile salmonids (Washington Department of Fisheries 1989). However, when water depth was low and canal flow was high, most approach velocities slightly exceeded criteria for salmon fry (0.4 fps). Sweeping velocities met criteria, exceeding approach velocities in all instances. Water velocity at the bypass channel entrance was less than the 2 fps velocity recommended in the Designer's Operational Criteria for this screening facility (USBR 1989). The reduced velocity was probably due to the fact that the pumpback pumps and traveling water screen were not operating. Operation of the pumps would have created an additional current in the bypass channel when the restrictive orifice is in place.

On 12 April, we observed seagulls flying over the canal downstream of the checkgates. This was at a time when river flow and fish numbers had suddenly increased and the pumpback pumps and traveling screen were operating. Upon closer inspection, we observed one mutilated juvenile salmonid in the water exiting from the checkgate structure. One week after this observation, six juvenile salmonids were found tangled in tumbleweeds removed from a lateral canal culvert approximately 3 miles downstream from the canal headworks (Richard Berg, West Extension Irrigation District, personal communication).

The discovery of juvenile fish in the canal downstream of the checkgate structure is a major concern. This indicates that the screening facility is not excluding fish from the water diversion. Additional evaluation will need to be performed to determine the cause and extent of this screening failure.

Sampling and bypassing outmigrating juvenile salmonids is impossible when river flow is less than 50 cfs and the headworks water elevation level drops below 403.4 ft above sea level. Water level below that mark precludes flow over the top of the inclined screen. Low river flow (< 35 cfs) resulted in no flow through the juvenile sampling-trapping facility from 19-22 April. On 18 April, river flow decreased overnight from approximately 46 cfs to 25 cfs and the headworks water elevation dropped to 401.5 ft. No auxiliary water was available due to critically low water levels, and sample tank oxygen was depleted. Approximately 500 dead or stressed juveniles were removed from the sample tank and flume. From 17-22 May, a similar but less severe situation occurred. Headworks water level was again too low (< 403.3 ft) to bypass fish and river flow was less than 50 cfs. During critical passage situations, a number of adjustments were made at the facility to pass water and fish through the system. These included lowering the inclined screen and fish separator to their lowest position, covering the perforated plate at the fish separator to prevent loss of water, and closing the bypass weir gate and transfer flume perforated plate completely.

These critically poor passage situations point to the need to better regulate the water level in the headworks, if possible, and perform other operations in a timely manner to facilitate trapping of fish for sampling or hauling. A juvenile salmonid trap and haul operation during low flows is not possible if an adequate headworks water level cannot be maintained. Operation of the pumpback pumps and traveling water screen, opening (or closing) the headgates sufficiently, and closure of the eastbank fish ladder attraction water all improve bypass conditions and should be immediately implemented when necessary.

All operating criteria of the WEID canal are based on a normal water surface elevation of 404.1 ft above sea level in the headworks area (USBR 1989). The 404.1 ft elevation is based on the normal operating water surface being 0.2 times the drum screen diameter below the top of the drum screens. To maintain a 404.1 ft water surface elevation in normal operation, the headgates should be fully opened and the downstream check structure used to regulate flow into the canal.

On numerous occasions we observed the constant regulation of headgate openings, at times to as low as a 1-ft opening on all gates. Although no correlation between headgate opening and fish condition has been made, it is possible that a decreased headgate opening could cause injury to fish. Debris accumulations or obstructions at the headgates cannot be observed because the forebay area in front of the headgates is never dewatered. If obstructions are present, limiting the gate opening may force fish into trash piles, causing injury.

Debris passing through the trashracks enters the bypass system and can cause problems. When flows are low, large pieces of debris are more frequently found in the system (Richard Berg, WEID, personal communication). During low flow periods this year, large debris accumulated on the fish separator. On occasion, debris became wedged in the slotted orifice and tended to accumulate in the surface water on the upstream side of the orifice plate. The critical area for a debris blockage is the 24-in diameter fish return pipe. With the large pieces of debris observed coming into the bypass facility (but intercepted at the separator), the potential for debris obstructions in the bypass pipe exists. This problem is compounded by the pipe length (> 100 ft) and limited pipe access and can be exacerbated in high flow years when the debris load in the river is greater. The discovery of a debris blockage in the bypass pipe where a gap exists between two adjoining pipes illustrates the potential for debris problems.

Sampling activities were more efficient after modifications were made to the juvenile salmonid sampling-trapping facility. We were able to concurrently sample the juvenile salmonids and bypass nonsampled fish during the majority of the spring outmigration. The ability to efficiently sample fish will prove valuable for future research and monitoring endeavors. The facility modifications were designed to reconvert from a sampling mode to a trap and haul mode with only minor adjustments.

Placement of the inclined screen, fish separator, and restrictive orifice in the bypass channel for the entire season partially affected prescribed operation of the bypass. Operating criteria developed by the National Marine Fisheries Service states that when river flow exceeds 150 cfs, all pumps are to be off, all sample facilities removed, and the terminal bypass gate fully opened. A full bypass mode was not possible with the sampling facilities in place during times of high flows, as bypass flow was restricted by the orifice plate. Thus, bypass discharge was always much less than the 25 cfs expected in a full bypass mode with river flow > 150 cfs. Fish bypassed at all flows and during peak passage periods were necessarily routed through the sampling facility. For a full bypass mode to occur, the inclined screen, fish separator and restrictive orifice would need to be removed along with the 6-in discharge pipes routed into the downwell at gate 2 (Figure 2). In addition, continual use of the restrictive orifice without concurrent operation of the pumpback pumps and traveling water screen reduced velocities through the bypass channel entrance to less than the 2 fps velocity required to prevent fish from returning to the screening area.

We did not determine bypass discharge during operations, but assumed that it was between 5 and 10 cfs. If a constant 0.50 ft differential across the orifice plate had occurred, then bypass discharge would have been a constant 5 cfs. However, this differential varied with water surface elevation and weir gate position. In addition, we observed water leakage past the inclined screen that continually flowed into the bypass channel. The origin of this leakage remained unknown. Although an obvious "loss" of water was occurring, the leakage provided continuous inflow for juvenile salmonids remaining in the bypass channel when river flows were extremely low and bypass operations ceased. During a severe water shortage, this lost water could not be retained for irrigation purposes.

After the bypass pipe was unplugged on 30 March, we continued to observe few fish exiting from the bypass outfall structure even when large numbers of fish were entering into the bypass system. This became particularly obvious in mid-April when numbers of fish entering the juvenile evaluation area were very high, yet relatively few fish were returning to the river. A close inspection of the terminal end of the bypass channel revealed a high concentration of fish in the area between the lower bypass gate and outfall. Fish were apparently holding up in this slack water area. However, fish eventually exited the bypass and returned to the river since fish concentration became less obvious with time.

The observation of dead juveniles flushed from the bypass during the preliminary watering-up of the canal headworks indicates that fish remain in the bypass system after operation ceases. Apparently, there is no means to ensure that all fish are returned to the river.

The terminal bypass channel is designed for a reduction in flow of 25 cfs or greater before reaching the outfall. However, the design does not appear to be effective in bypassing fish at low flows (< 10 cfs). Water velocity during low bypass flows did not appear strong enough to forcibly pass fish out into the river. A low bypass flow will occur when sampling facilities are in place or river flow is low.

During the entire juvenile salmonid outmigration, we observed passage through the eastbank ladder from the east viewing room. Passage of juveniles through the ladder appeared to be similar to passage through the westbank facility. When the bypass was shut down in late January, we observed fish jumping in the forebay of the dam. These fish evidently were released from a beaver dam blockage at Minthorn (RM 64.5). After several days, we no longer observed activity in the forebay but observed juvenile fish in the pool directly below the eastbank ladder. The observation of juveniles in the adult ladder indicates that smolts use the ladder as a means to bypass the dam even when the bypass is in operation. It is also possible that water passing over the attraction water weir serves as a bypass vehicle for juveniles. These observations raise the question as to whether the ladder is designed to bypass juveniles in an effective and noninjurous manner.

RECOMMENDATIONS

(1) The headgates and checkgates to the WEID canal should be automated to ensure proper water level elevations in the forebay and headworks area at all times. A normal operating water surface elevation of 404.1 ft at the drum screens should be maintained whenever possible.

(2) Headgates should be opened greater than one foot at all times to prevent injuries to incoming juvenile salmonids. Overall regulation of water level in the headworks area should be accomplished through use of the check structure.

(3) Staff gauges need to be installed upstream and downstream of the orifice plate so that head differential may be determined.

(4) A secondary trashrack structure needs to be installed at the bypass entrance to prevent large debris from entering the bypass.

(5) A supplementary aeration system to the holding tanks should be made available to supply oxygen to sample fish in times of critically low water flow.

(6) Juvenile salmonid trap and haul operations should be performed at Three Mile Falls Dam when flows decrease to < 50 cfs to prevent bypassing fish into deteriorating river conditions. During critically low flow, smolts bypassed into the river are vulnerable to predatory birds. We recommend that CTUIR become familiar with the trap and haul facilities and the operation of equipment and ensure that the system is ready for operation when necessary.

(7) The terminal end of the bypass pipe, where a gap exists between two adjoining pipe sections, should be modified to prevent debris hangup and obstructions. We recommend an epoxy filler to eliminate the gap.

(8) Construction of a secondary bypass system should be considered for use during low flows or when bypass discharge is < 10 cfs to efficiently return fish to the river.

(9) A slide gate under the fish separator perforated plate is needed to control the amount of water elimination during low flow periods. We used plastic sheeting as a temporary measure to prevent water loss in 1990.

(10) We recommend that the Three Mile Falls fish screening facility be operated according to operating criteria developed by the National Marine Fisheries Service and criteria outlined in USBR (1989).

(11) A full scale evaluation should be performed at Three Mile Falls Dam bypass system in the WEID canal to determine specific deficiencies in design, construction and operation and to ensure that the system functions as intended. The study objective should be to evaluate the passage of juvenile salmonids through the bypass system including the evaluation at design flow of injury and mortality rates, and passage of juvenile salmonids through and over the screens.

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APPENDIX A

Operating Criteria, Three Mile Falls Dam Fish Screening Facility (Revised 2-15-90)

Canal water surface elevation should not be lower than 403.5 ft. Depending on the amount of streamflow past the dam, one of three bypass operational modes can be employed:

1. Operation when streamflow past dam exceeds 150 cfs (according to the Umatilla gauge):

(During this period, all pumps are off, all sampling facilities are removed and the bypass gate is fully open.)

A. Traveling water screen will not operate.

B. Gate G-1 is closed.

C. Pumps P-1 and P-2 are off.

D. The 5 cfs orifice insert plate is removed from Slot

E. Remove inclined screen and fish separator from bypass channel.

F. Close Gate G-2.

G. Leave Gate G-3 open.

H. Place stoplogs in Slot B (to full height)

I. Lower Gate G-4 so that weir crest is at elevation 401 ft. (Mark on the gate stem so gate is not lowered too far.) The gate crest should be 2.5 ft. below the canal water surface.

J. Closure Gate G-5 should be in the raised and fully open position.

K. Lower Gate G-6 to full-open position.

2. Operation when streamflow past the dam is less than 150 cfs, and screen bypass flow is to be 5 cfs, directed to tailwater:

(This will occur when streamflows are diminishing *in* the spring, and especially during interim pumping operations in the lower river.) Initiation of this operating mode should be determined by ODFW and WEID.

A. Operate traveling water screen.

B. Close Gate G-1.

C. Operate Pumps P-1 and P-2.

D. Insert 5 cfs orifice plate into Slot A.

E. Remove inclined screen and fish separator from bypass channel.

F. Close Gate G-2

G. Leave Gate G-3 open.

H. Place stoplogs in Slot B.

I. Raise Gate G-4 weir crest to elevation 402.6 ft. (distance from canal water surface to weir crest of 0.9 ft.)

J. Closure Gate G-5 fully open.

K. Set Gate G-6 at elevation 394.5 ft (mark on gate stem).

3. Operation when streamflow past the dam is zero:

(This will occur after river flows have dropped off, but there are still outmigrating fish to be collected and transported. Or, this may occur during sampling and passage evaluation activities.) This operation will also be initiated at the discretion of ODFW and WEID.

A. Traveling water screen operates.

B. Pumps P-1 and P-2 operate.

C. Insert orifice plate into Slot A.

D. Install inclined screen in bypass channel.

E. Remove stoplogs in Slot B.

F. Install fish separator in bypass channel.

G. Position holding tanks to receive flume flows from fish separator.

H. Gate G-1 closed.

I. Open Gate G-2.

J. Open Gate G-3.

K. Pump P-3 operates.

L. Adjust Gate G-4 to provide a differential of 0.50 ft across the insert orifice plate.

M. Close Gate G-5.

(Gate G-1 may be used to sluice sediment accumulating behind the traveling screens prior to operation of P-1 and P-2.)

Notes:

1. One partial bulkhead, several feet high, should be installed in the slots immediately downstream of each drum screen. The insert elevation of each partial bulkhead should be 8-10 in. above the concrete slab elevation. This will greatly reduce sediment build-up in each screen bay.

2. The USBR should be notified several days in advance of when the juvenile trap is to be installed.

REPORT B

1. Examine the passage of adult salmonids at Three Mile Falls Dam.

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ABSTRACT

The Confederated Tribes of the Umatilla Indian Reservation (CTUIR) monitored river conditions (flow, water temperature, and turbidity) at Three Mile Falls Dam on the Umatilla River, from October 1989 through June 1990; sampled adult and jack salmon from the east bank holding pond: acquired, installed, operated and reviewed video tapes from video recording equipment located at the east bank ladder viewing window; and visually observed adult salmon passage through the ladder and in the river below the dam. Trap counts indicated 4,623 coho salmon (Oncorhvnchus kisutch), 602 fall chinook salmon (0. tshawtscha), 1,668 summer steelhead (0. mvkiss), and 2,188 spring chinook salmon returned to the dam during this project period. River flow and turbidity were positively correlated. The fall season migration of coho salmon and fall chinook salmon did not noticeably correspond to river flow; flow during this time ranged from 150 to 250 cfs. Peaks in steelhead and spring chinook salmon passage did coincide with river flow events, especially when flows exceeded 250 cfs. A total of 85 days were recorded on video tapes, and of the tapes reviewed, 509 steelhead and 1286 spring chinook salmon were counted. A total of 5,673 individual observations of steelhead passing the window were required to account for the 509 steelhead that passed because the fish went back and forth across the viewing window many times. A total of 18,626 individual observations of spring chinook salmon passing the window were required to account for 1,286 fish past the window. The video equipment counted 96% of the steelhead trapped during the periods when both methods were used to monitor passage. The video equipment counted 5% more spring chinook than the number trapped. The large amount of back and forth movement recorded on the video tapes hindered recording of fish length and fin clip information.

We hypothesize that the back and forth activity past the east bank viewing window occurs when fish that have passed through the last baffle of the fish ladder and through the V-trap grate are prevented from passing into the forebay through the fishway exit and hold in the viewing area while trying to pass into the Denil steep pass. Questions arise as to the effectiveness of the fish passage facility with respect to adult fish passing from the ladder into the steep pass. However, the fish in the viewing window area have passed the facility, and we hypothesize that the amount of back and forth movement would be greatly decreased if the fish were allowed to freely swim onward out the fishway exit.

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Special thanks to the following Confederated Tribes of the Umatilla Indian Reservation (CTUIR) employees for their assistance. Douglas Olson, Larry Cowapoo, and Melvin Farrow for collecting field data and reviewing the video tapes. Celeste Reeves and Julie Burke for assistance with preparation of this report. Joe Richards for administrative assistance and Gary James for contract management, assistance, and critical review.

INTRODUCTION

Three Mile Falls Dam, its headworks, and east bank fish ladder were constructed in 1914 by the Bureau of Reclamation to divert water for irrigation. The original pool-and-weir ladder was not operational from 1964 until 1984. This ladder was plagued with problems, such as false attraction flows, channel obstructions, and sedimentation blocking the upstream exit. Modifications to the ladder to improve fish passage conditions were completed by 1987, and included modified entrances and increased attraction flows, changes to ladder steps to prevent stranding and adult delays in the ladder, and modified exit structures. The study reported here was designed to evaluate passage of adult salmon at Three Mile Falls Dam to ensure that adult passage facilities are operating as designed and any mortality that results from injury or delay due to the facilities is documented and corrective actions recommended. In this report, we summarize the methods developed in 1989 and 1990 to evaluate improvements at Three Mile Falls Dam with respect to upstream migration passage. Methods included recording river conditions, visually observing passage through the dam, video taping passage past the ladder viewing window, and enumerating salmon trapped after passing the dam.

METHODS

We monitored river conditions (flow, water temperature, and turbidity) at Three Mile Falls Dam from October 1989 through June 1990; sampled adult and jack salmon from the east bank holding pond: acquired, installed, operated and reviewed tapes from video recording equipment located at the east bank ladder viewing window; and visually observed adult salmon passage through the ladder and in the river below the dam. The west bank adult facility was not watered up during the 1989-1990 salmon migration. Therefore, no salmon were trapped or video taped in the west bank facility. River temperature was recorded in the east bank ladder near the viewing window at hourly intervals from October 4, 1989 through June 19, 1990 with a digital recording thermometer. The data was then downloaded into a computer and daily average temperatures were calculated and graphed. Turbidity was measured with a secchi disk in the forebay to the nearest tenth of a meter. Average daily discharge data from October 1, 1989 through May 18, 1990 was obtained from the U. S. Geological Service as recorded at the Umatilla gage approximately 1.5 km below the dam. The flow data reported for May 19 through June 19 was provided from visual observations in conjunction with incomplete gage data. Simple linear correlations of river conditions and fish passage were analyzed by calulating the product-moment correlation coefficient (r) and the probability of a zero correlation (P).

Carcass surveys were performed below Three Mile Falls Dam to the river mouth backwater (partly conducted as a tribal and state general fisheries management activity).

Species composition and enumeration of adult and jack salmon in the east bank holding pond was determined by sampling the fish in conjunction with the Umatilla Trap and Haul project. We defined jack coho salmon as less than 508 mm (20 in); jack chinook salmon as less than 610 mm (24 in): and subjack fall chinook salmon as less than 457 mm (18 in). These counts were used to record those fish that completed passage through the east bank facility, and to verify the counts obtained with video recording equipment through the ladder viewing window.

We acquired and installed video recording equipment in the east bank viewing room on February 23, 1990 and operated it intermittently until June 19, 1990 (Table B-l). The equipment consisted of a Panasonic[R] D5000 camera with a 6mm fixed focus lens mounted on a monopod with the lens four feet from the center of the window; a Panasonic[R] AG-6720 time lapse video cassette recorder (TLVCR), and a Panasonic[R] WV-3203B power supply (Figure B-l). The TLVCR and camera were connected to the power supply (the camera was connected with a Panasonic[R] WV-CA-10 cable), and the power supply and TLVCR were plugged into a SL Waber[R] EP7S surge protector which was plugged into the wall outlets. A monitor was attached to the system during installation to view what the camera was recording. The camera was mounted sideways to completely encompass the entire window without overlapping the wall surrounding the window (VCR cameras record a greater width than height, yet the window is higher than wide). During installation, the lens iris was adjusted all the way open (f-stop 1.8), the SES/NORMAL selection was set to normal, and the Automatic Gain Control (AGC) set on high to provide high sensitivity at low illumination. The White Balance Selection Switch (AWC/ATW) was set on automatic white balance (AWC) and the camera aimed at a white piece of paper and the White Balance Set switch depressed while the white balance automatically adjusted for optimum recording of two different light sources (eg., indoor and outdoor lighting). Then, the lens iris (f-stop) was adjusted along with the background focal control (flangeback adjustment gear) to find the optimum balance between the amount of light allowed in and the focal point (the light and focal point work inversely to each other). Therefore, illumination was maximized along with depth of field so that the recordings were both well lit and focused throughout the one foot distance between the backlighting chamber and the viewing window.

When the system was powered up, the camera sent its picture to the TLVCR, which was loaded with a standard VHS video cassette and allowed recording of extended periods of time. A total of 85 days were video taped, approximately 30% of the total number of days that salmon passed Three Mile Falls Dam. We recorded in the 72-hour mode, enabling us to record three days of passage on each tape. In the 72-hour recording mode, the tape recorded a field every 0.6 second, yet recorded the real time of day on each field of tape. The date and time label was positioned on the upper corner of the tape to minimize overlap with recorded fish. The tapes were fast-forwarded and rewound in a fast-forward/rewind machine before recording in order to fluff the tapes. The TLVCR

Table B-l. Video recording and tape change dates - Threemile Falls Dam, Umatilla River, east bank, 1990.

Tape #	Video Tape In Date	Hour	Video Tape Out Date	Hour	Comments
1	2/23	1500	2/26	1015	Camera Installed
2	2/26	1015	2/28	0700	
3	2/28	0700	3/2	1254	
4	3/2	1255	3/5	1008	3/3-5 Malfunction
5	3/5	1008	3/7	0917	
6	3/7	0915	3/9	1135	
7	3/9	1135	3/11	0800	
8	3/11	0800	3/12	1425	
9	3/12	1425	3/15	0733	
10	3/15	0737	3/18	1315	
					Equipment Stolen
11	3/22	1510	3/25	1255	
12	3/25	1255	3/27	1306	
13	3/27	1306	3/28	1430	
					Door Lock Improved
14	4/2	0935	4/5	1400	
					VCR Malfunction
15	5/1	1400	5/2	1215	
16	5/2	1215	5/4	1200	
17	5/4	1200	5/7	1053	
18	5/7	1053	5/10	1105	
19	5/10	1105	5/11	1010	
20	5/11	1010	5/14	1200	
21	5/14	1200	5/17	1225	
22	5/17	1225	5/19	1745	
23	5/19	1746	5/22	1252	
24	5/22	1257	5/29	1045	
25	5/29	1045	6/1	1036	
26	6/1	1038	6/4	1007	
27	6/4	1007	6/7	0947	
28	6/7	0945	6/12	0915	
29	6/12	0915	6/15	0930	
30	6/15	1001	6/19	1300	
31	6/19	1302	6/21	1200	

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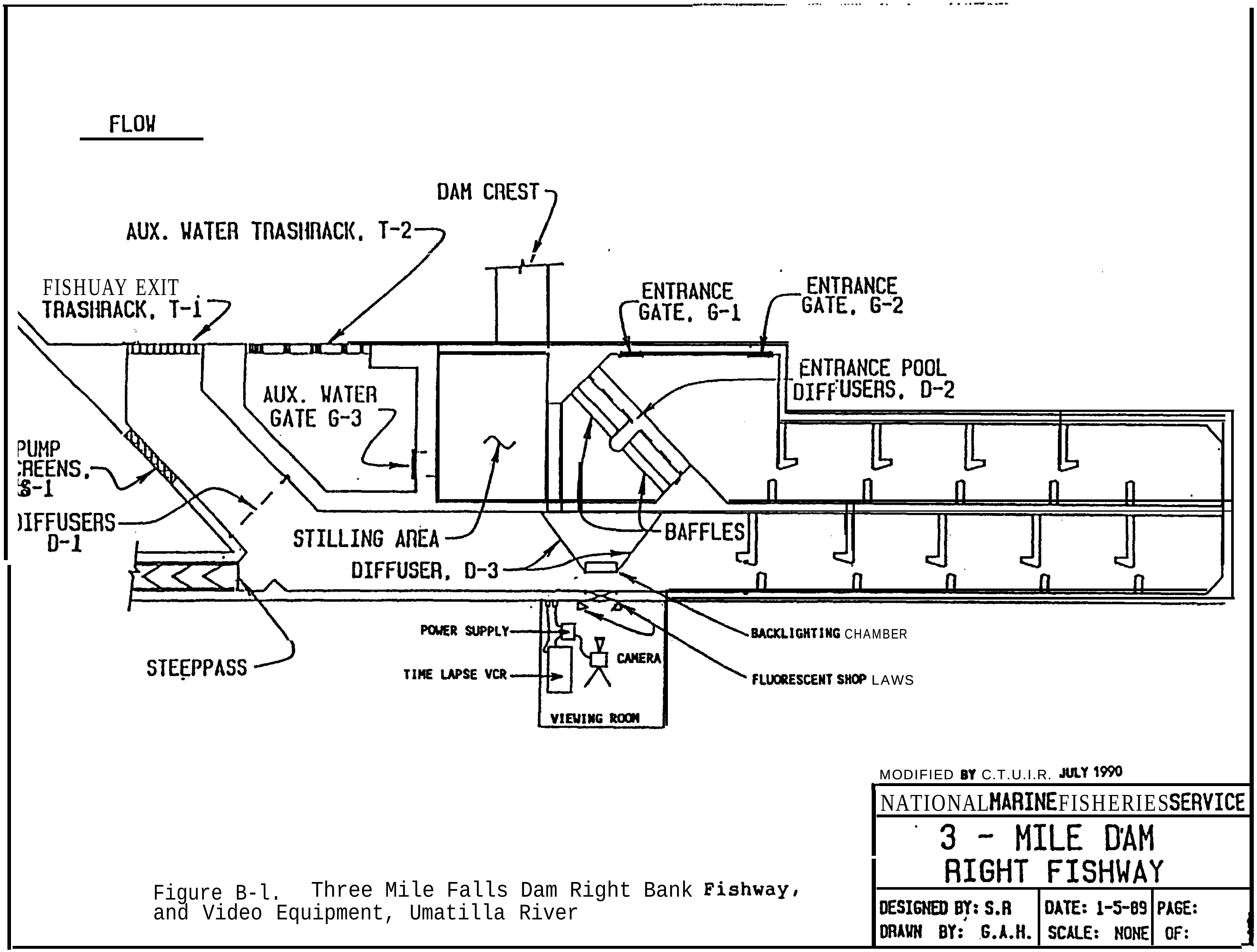

Figure B-l. Three Mile Falls Dam Right Bank Fishway, and Video Equipment, Umatilla River was locked in the record position each time the tape was changed, to prevent accidental adjustments or disruptions. If power to the system was interrupted, the system would automatically come back on when power was restored, leaving a message on the tape indicating when power was lost. When tapes were changed, the date, start time and end time was recorded on the tape label and in a log book, along with secchi disk data and general comments. The TLVCR heads and the camera lens were cleaned approximately once a month. The viewing window and backlighting chamber were well cleaned before the ladder was watered up, and approximately once a week thereafter to prevent algae build up. The backlighting chamber was adjusted to provide a one foot clearance between the chamber and the viewing window. The backlight was operated only during periods of extreme turbidity (less than approximately 0.25 M), and not operated in clearer water in order to prevent the lights from silhouetting the fish. Fluorescent shop lamps were installed along the sides in front of the window to allow recording of passage at night, and to enhance recording during periods of high turbidity.

The video tapes were reviewed using a high resolution Ikegami[R] CMU1450 monitor and a special Panasonic[R] AG-1960 VCR playback machine that allowed ready forward, rewind, and freeze-frame capabilities. Data recorded included date and time, tape number, date the tape was reviewed, the tape reader, backlight on or off, and general comments (eg., non-salmonid species, smolt passage). Species were identified, and fish movements upstream past the window, downstream past the window, upstream into the viewing area and then back downstream, and downstream into the viewing area and then back upstream were enumerated. These enumerations were assisted by use of multiple unit tally meters and the totals for each hour recorded.

Visual observations of coho salmon and fall chinook salmon past the viewing window and in the pools directly below the ladder entrance were recorded. These observations included general observations of numbers of fish passing into the base pools below the ladder entrance and were compared to numbers of fish in the holding pond. Also, on May 3 and May 10 the tape reader recorded fish passage through the viewing window from 1100 to 1200 hours. Visual and tape counts were compared to further verify the video recordings.

RESULTS

River Conditions, Trapping, and Visual Observations

Average daily temperatures ranged from 1.6 C (34.9 F) in February to 24.7 C (76.5 F) in July (Figure B-2, Appendix B-l). Turbidity ranged from the clearest water in mid-December and April (1.8 M) to the most turbid water (0.2 to 0.3 M) in mid-March and June (Figure B-3, Appendix B-l). The turbidity of the river was significantly negatively correlated ($r=-0.710$, $P<0.001$) with the

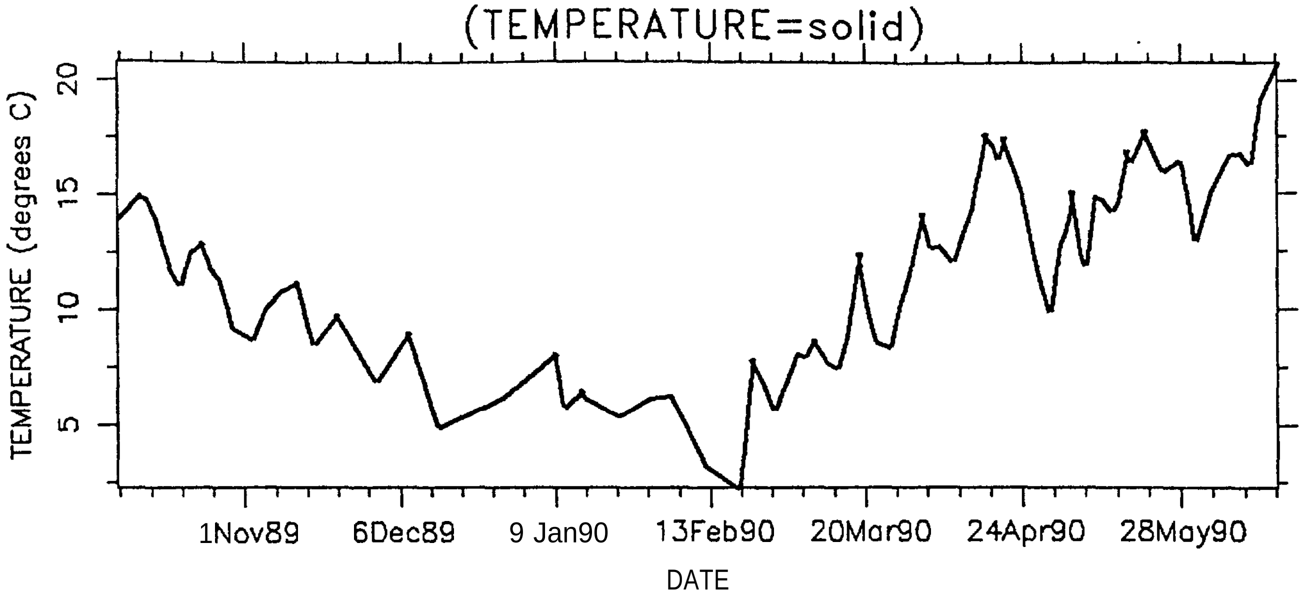

Figure B-2. Mean daily water temperature at Three Mile Falls Dam, Umatilla River, October 4, 1989 through June 19, 1990.

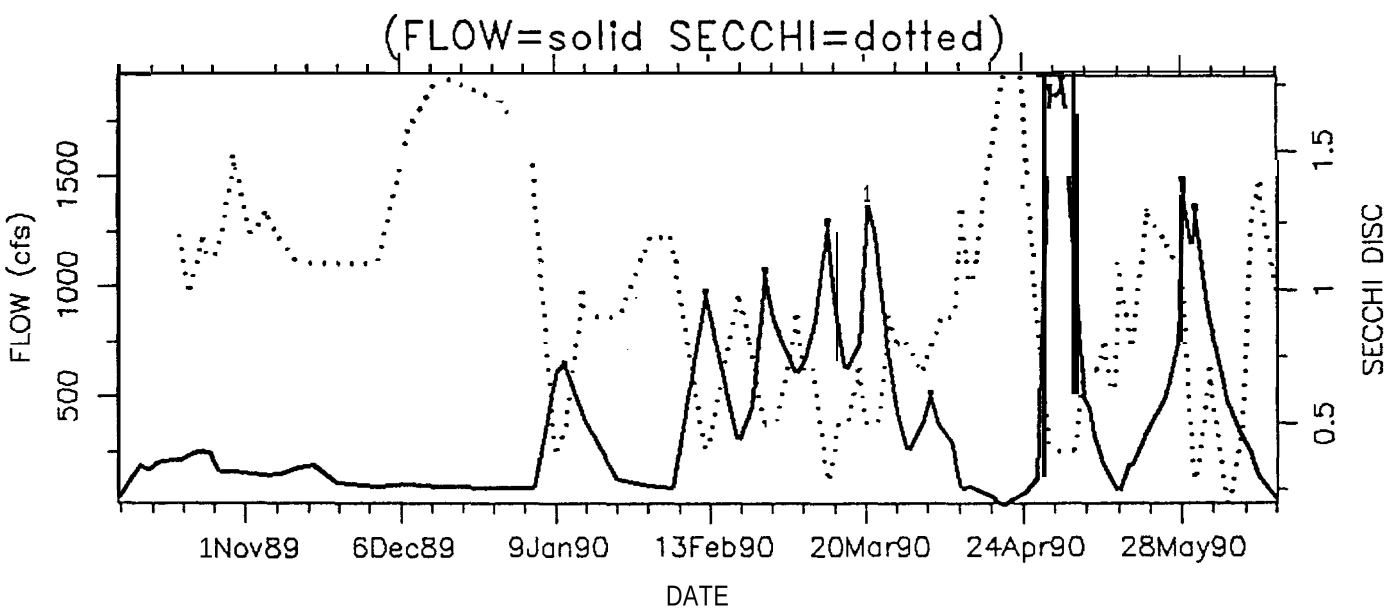

Figure B-3. Mean daily discharge as measured at the Umatilla gage (USGS provisional data): and secchi disk depths as recorded at Three Mile Falls Dam, October 1989 through June 1990.

river flows (Figure B-3, Appendix B-l). Average daily flows, as recorded at the Umatilla gage, peaked in early May and early June (greater than 1900 cfs). The lowest flows were seen during the end of December (less than 100 cfs) and in mid-April (less than 50 cfs). Flow was not correlated with temperature ($r=-0.086$, $P=0.433$), and temperature and turbidity were not correlated ($r=0.109$, $P=0.332$).

Carcass surveys between Three Mile Falls Dam and the river mouth backwater were conducted on November 22 and December 15. A total of 92 dead fall chinook salmon (15% of the fall chinook that were trapped at the dam) and 52 dead coho salmon (1% of the coho that were trapped), along with 75 redds were observed (Table B-2).

Trap counts indicated 4,623 coho salmon (4,102 adults and 521 jacks), 1,668 steelhead (O. mvkiss), 602 fall chinook salmon (279 adults, 247 jacks, and 76 subjacks), and 2,188 spring chinook salmon (2,156 adults and 32 jacks) returned to Three Mile Falls Dam from September 1989 through June 1990 (Figure B-4 and Appendix B-1). The coho salmon and fall chinook salmon passed over the dam from early October through early January, the steelhead migrated from early October through early May, and the spring chinook salmon from early April through the end of June.

The majority of the coho salmon and fall chinook salmon passed the dam when flows were between 150 and 250 cfs, and flows did not exceed 258 cfs during this period. There was no correlation ($P>0.289$) between river conditions (temperature, turbidity, or flow) and upstream migration of these two species (Figure B-5, Figure B-6). However, minor flow increases (approximately 200 to 250 cfs from October 20 to 27; and from 150 to 200 cfs from November 8 to 18) along with an approximately 1.5 degree increase in temperature during the same time periods appear to roughly coincide with coho salmon and fall chinook salmon peak migration periods. During these two periods, 3,144 coho salmon (72% of the total run) and 342 fall chinook salmon (55% of the total run) were trapped at the dam.

The majority of steelhead passed Three Mile Falls Dam from mid-February through March. There was no correlation ($P>0.021$) between river flow or turbidity and steelhead passage (Figure B-7). There was a significant negative correlation ($r=-0.449$, $P<0.001$) between river temperature and steelhead passage. In early January, flows increased from 100 cfs to over 600 cfs, and over 400 steelhead (24% of the total run) were trapped shortly thereafter. From mid February through the end of March, four major peaks in flows occurred (from 100 to 1000 cfs, 450 to 1100 cfs, 850 to 1300 cfs, and 750 to 1430 cfs) and 750 steelhead were trapped (45% of the total run). The lag between flow increases and steelhead trapped displayed in Figure B-7 may partly be due to the periodicity of when the trap was checked, and may also be partially due to the steelhead migrating on the downward edge of the flow events.

Table B-2. Results of spawning ground surveys conducted in the Umatilla River from 700 feet below Three Mile Falls Dam to the river mouth backwater at the City of Umatilla.

		Redds		Live Fish				Dead Fish			
Dates	Miles	Occ	Unocc.	CHF	COH	Unid.	Total	CHF	COH	Unid.	Total
11/22	2.5	19	23	8	4	15	27	37 A/	18 B/	6	61
12/15	2.5	0	56	0	1	1	2	55 C/	34 D/	11	100
Total	2.5	19	56	8	5	16	29	92	52	17	161

A/ M:F=1:2.7 (n=34); 31 spawned out, 0 prespawn morts; 3 jacks; 8 CWT, 6 snouts

B/ M:F=1:3.0 (n-12); 6 spawned out, 3 prespawn morts; 3 jacks: 2 CWT., 1 snouts

C/ M:F=1:1.9 (n=49); 39 spawned out, 2 prespawn morts; 0 jacks; 21 CWT,15 snouts

D/ M:F=1:1 (n=26); 11 spawned out, 4 prespawnmorts; 5 jacks; 4 CWT, 2 snouts

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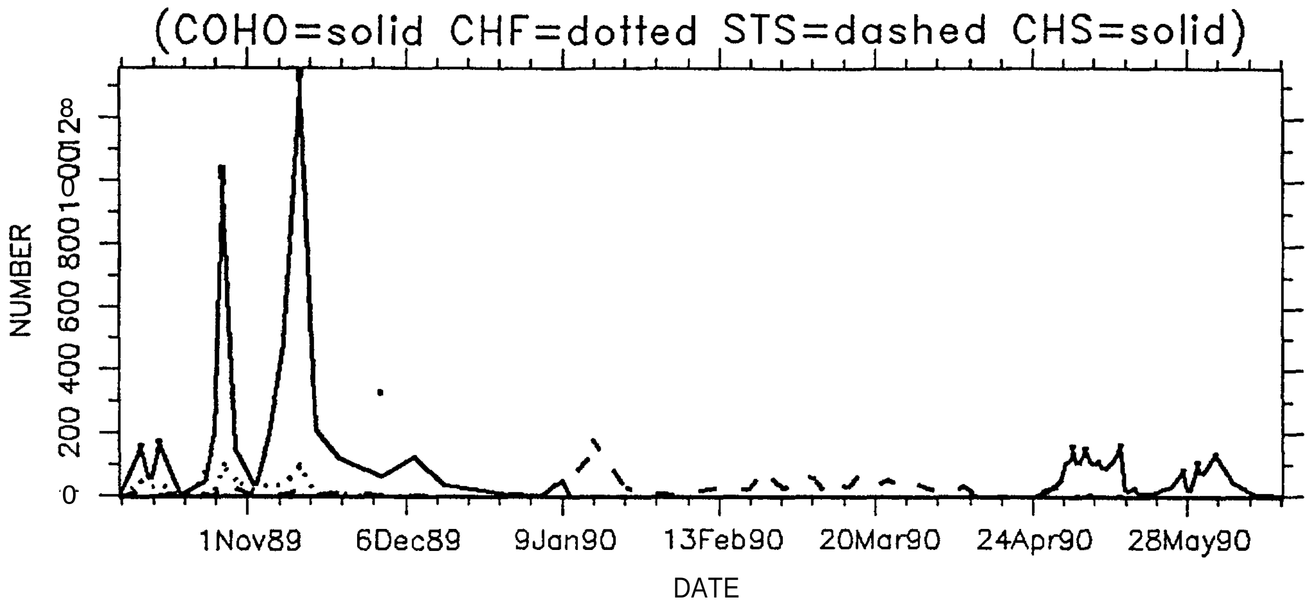

Figure B-4. Salmon returns to Three Mile Falls Dam, Umatilla River, October 1989 through June 1990.

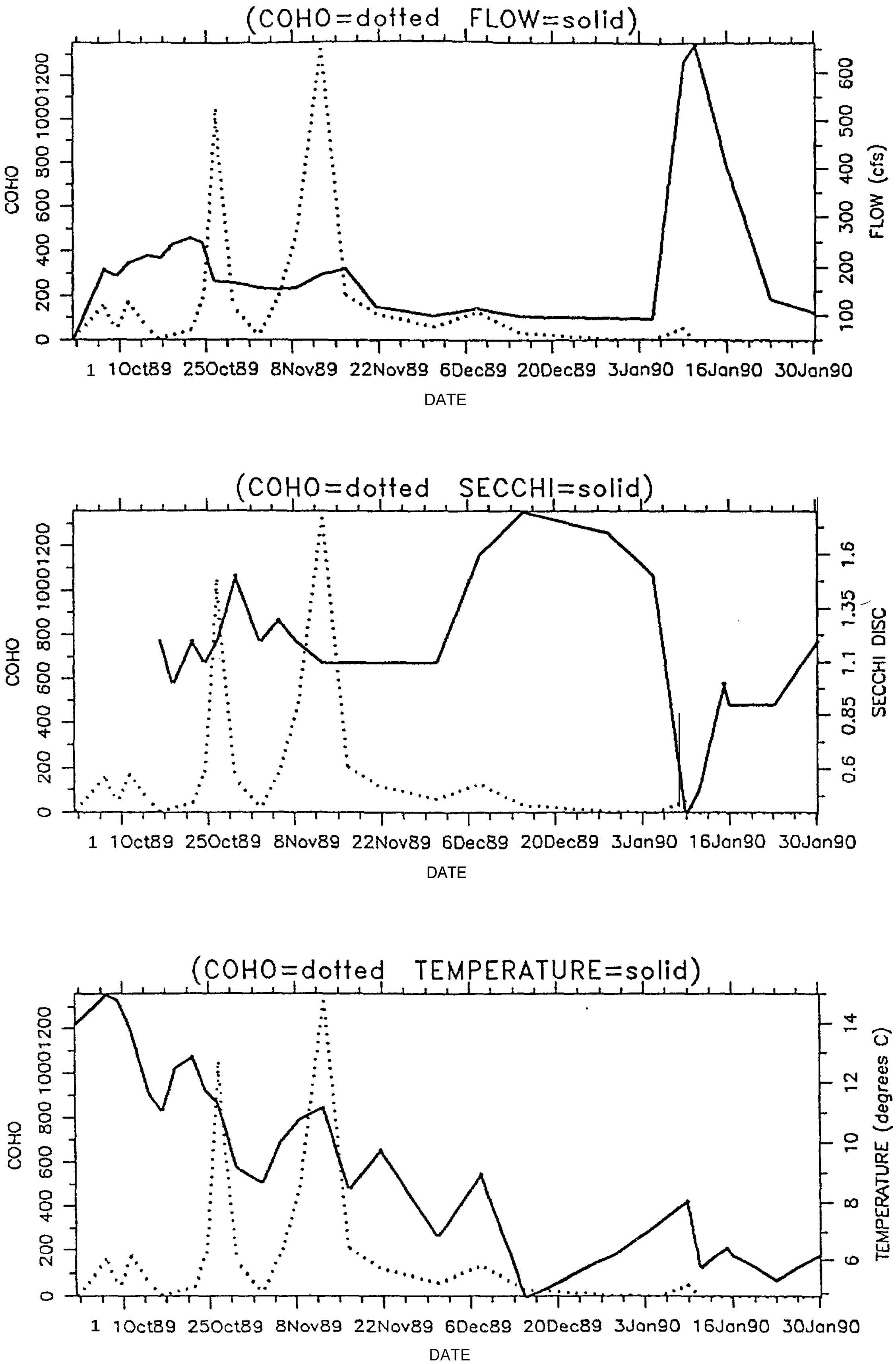

Figure B-5. Coho salmon returns to Three Mile Falls Dam, and mean daily flows, secchi disk depths, and mean daily temperatures, October 1989 through January 1990.

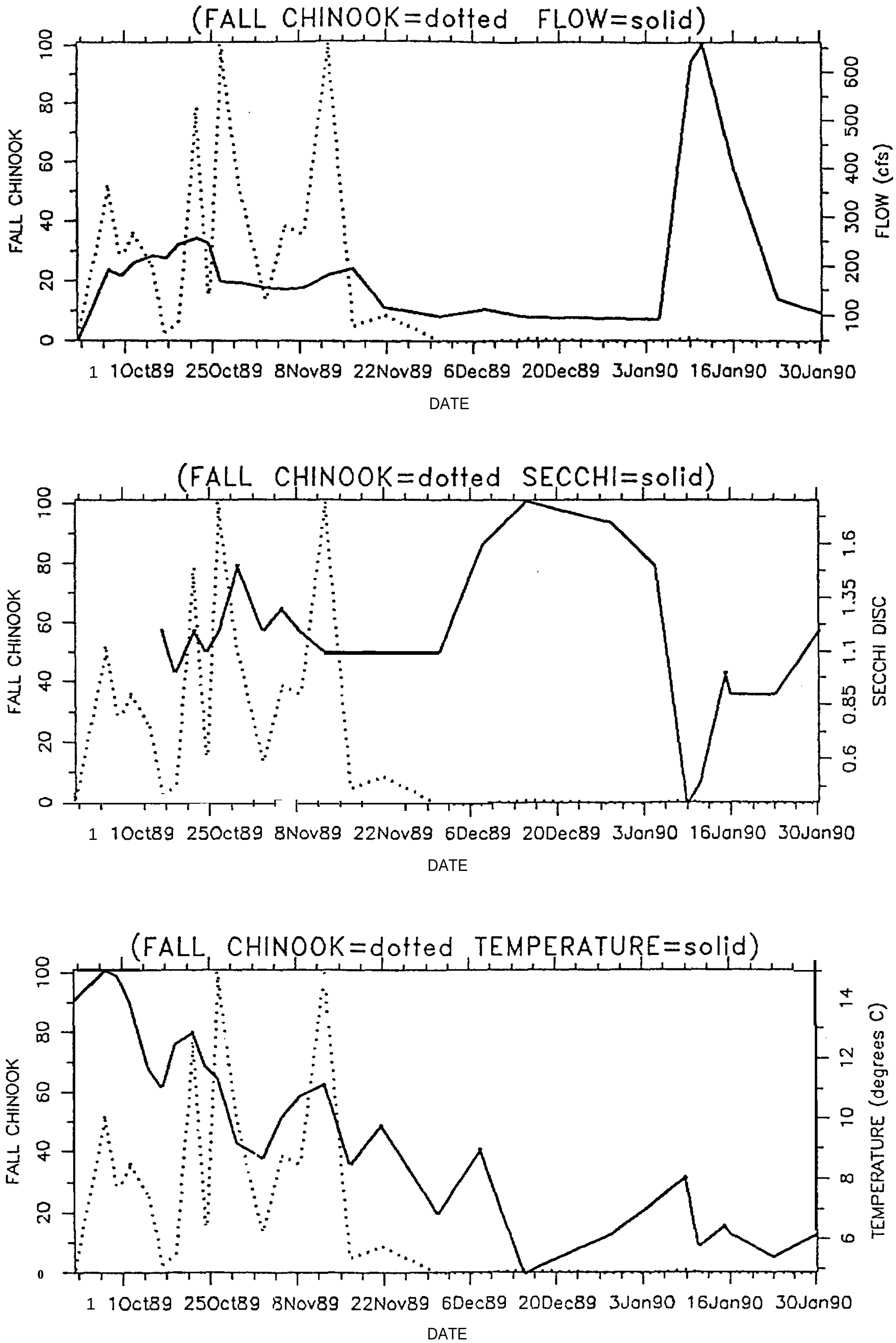

Figure B-6. Fall chinook salmon returns to Three Mile Falls Dam, and mean daily flows, secchi disk depths, and mean daily temperatures, October 1989 through January 1990.

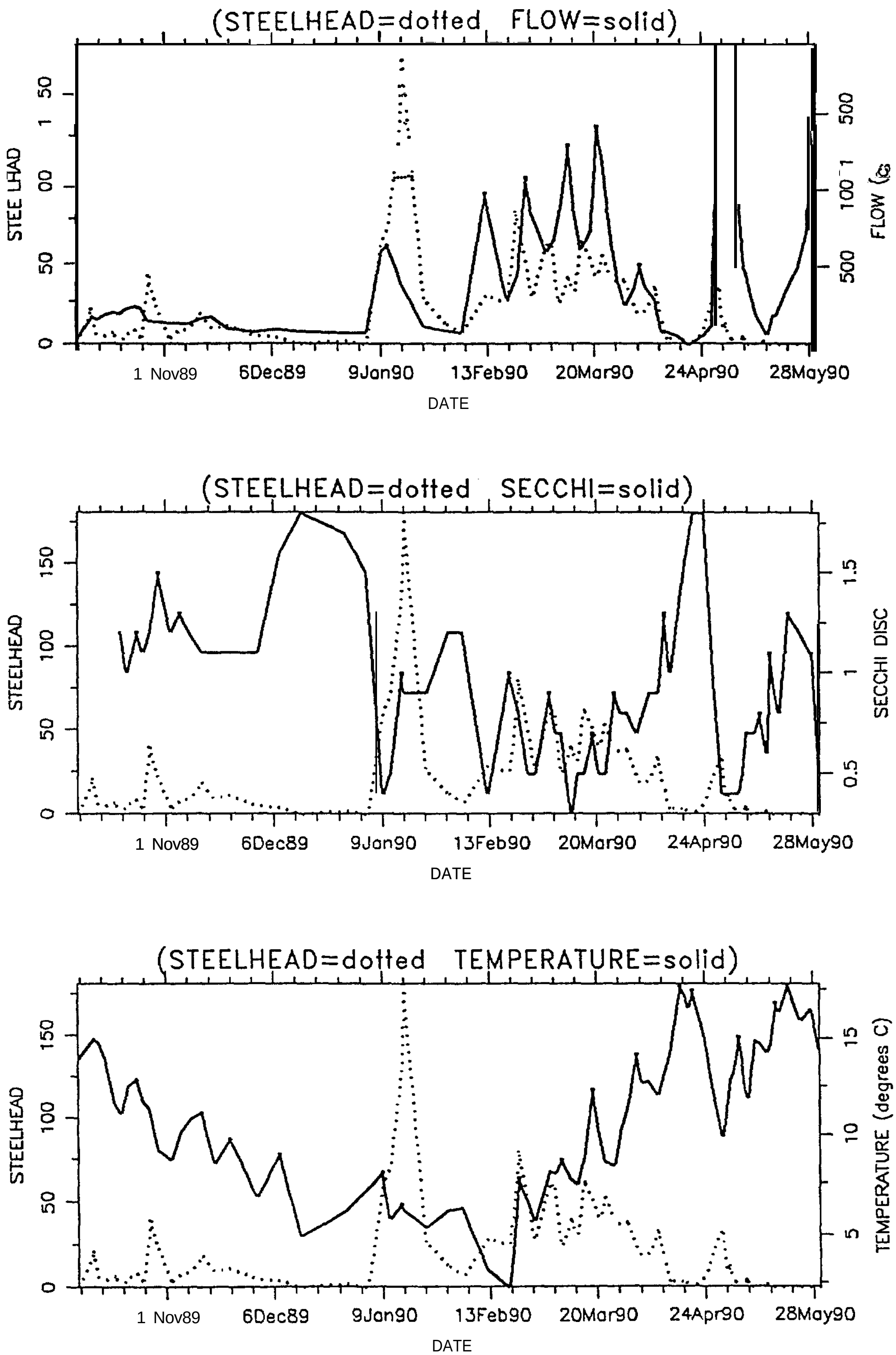

Figure B-7. Steelhead returns to Three Mile Falls Dam, and mean daily flows, secchi disk depths, and mean daily temperatures, October 1989 through May 1990.

Flows had decreased to 20 cfs by April 20. During the end of April through the first week of May, several large freshets produced flows averaging approximately 1,800 cfs and flows remained above 150 cfs for the remainder of the season. Another series of freshets occurred during the end of May and early June. Spring chinook salmon migration past Three Mile Falls Dam was significantly correlated ($r=0.585$, $P<0.001$) to these flows; and to turbidity ($r=-0.706$, $P<0.001$) (Figure B-8). From April 30 through May 14, flows averaged about 1,100 cfs, and 1,550 spring chinook salmon (71% of the total run) passed the dam. When flows decreased to 150 to 300 cfs, spring chinook salmon migration also decreased. From May 29 through June 4 flows averaged 1,400 cfs, and 340 additional chinook salmon (16% of the run) passed the dam.

Video Data and Visual Observations

During 33 days of taping steelhead migration, 509 steelhead were counted by reviewing the video tapes (Table B-3). A total of 5,673 individual observations of steelhead passing the window were required in order to account for the 509 steelhead that passed because the fish went back and forth across the viewing window many times. Steelhead went past the window in an upstream direction 2,435 times, and back down past the window 1,926 times; the difference being 509 fish. Steelhead went up into the viewing area, stopped at the window, and passed back down without passing the window 968 times, and 344 times they were observed coming down into the viewing area from above, stopping, then proceeding back up. On several occasions the fish stayed in the window for up to several hours at a time. Most of the steelhead movement appeared to be in the early morning hours, and in the early evening until dark. The vast majority of the fish passed the viewing area along the floor of the ladder.

We reviewed 21 days of video tape during the spring chinook salmon migration (Table B-3). A total of 18,626 individual observations of spring chinook salmon passing the window were required to count 1,286 fish past the window. During the 21 day period, spring chinook salmon went past the window in an upstream direction 7,912 times, and back down past the window 6,626 times: the difference being 1,286 fish. Spring chinook salmon went up into the viewing area, stopped at the window, and passed back down without passing the window 3,724 times, and 364 times they were observed coming down into the viewing area from above, stopping, then proceeding back up. Individual fish also stayed in the window for up to several hours at a time. The spring chinook salmon appear to move during hours of light, and very little movement was observed during hours of darkness.

During periods when we concurrently operated the video equipment and checked the trap, a total of 375 steelhead were counted on the video tapes and 392 steelhead were trapped (Figure B-9, Table B-4). The video equipment accounted for 96% of the fish trapped. During periods of the spring chinook salmon migration

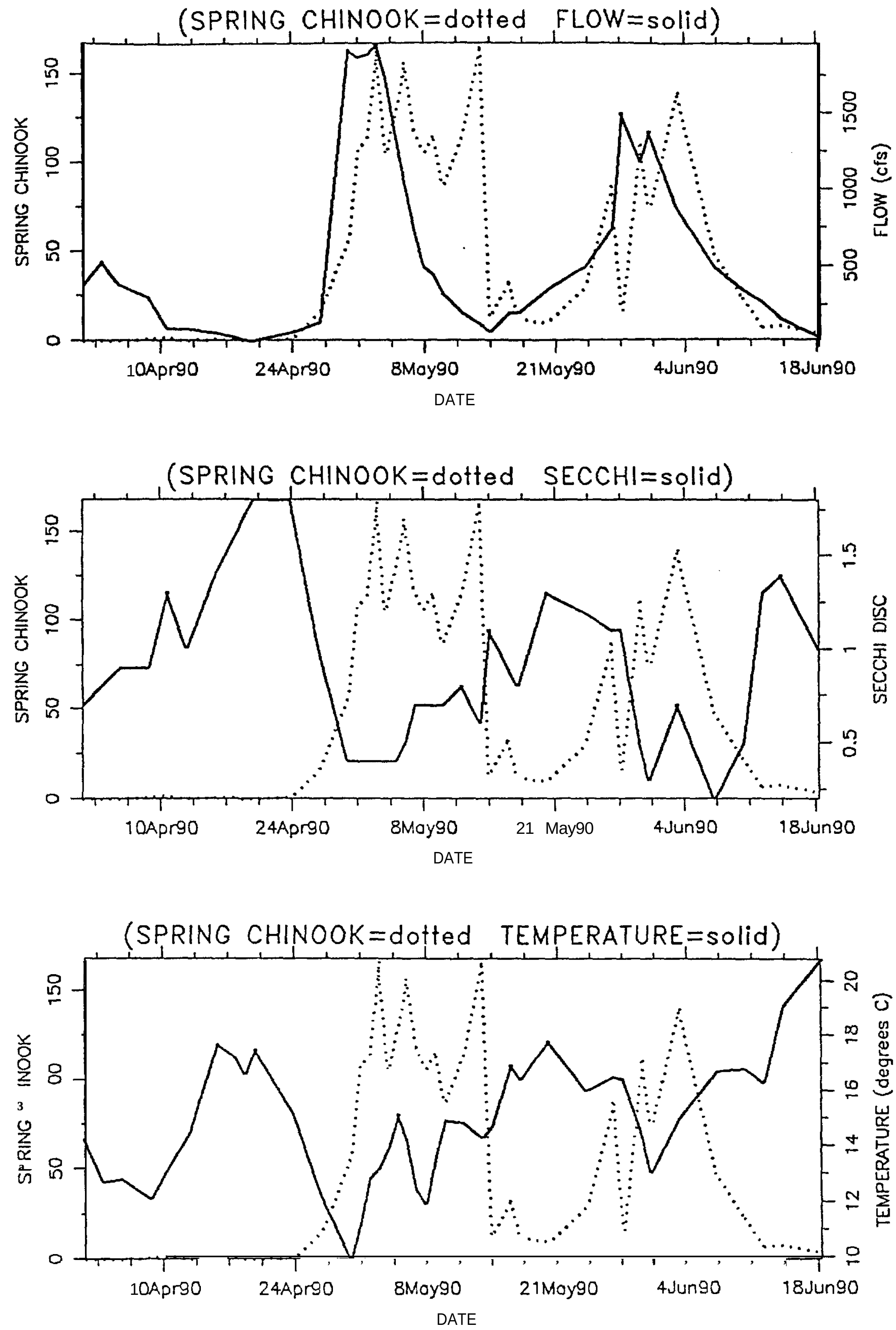

Figure B-8. Spring chinook salmon returns to Three Mile Falls Dam, and mean daily flows, secchi disk depths, and mean daily temperatures, April through June 1990.

Table E-3. Summary of video tape data for Three Mile Falls Dam, east bank, 1990.

Date	Start: Hour	End Hour	# Up		# Down		# Up then Down		# Down then Up		# Up minus # Down	
SPECIES A/				STS		STS		STS		STS		STS
2/23	1330			41		35		16		3		6
2/24				115		87		32		18		28
2/25				26		20		15		2		6
2/26				63		48		27		3		15
2/27				65		58		21		12		7
2/28				50		35		16		17		15
3/1				104		83		56		23		21
3/2		2400		131		105		39		25		26
				595		471		222		103		124
3/3-3/4 B/												
3/5	1000			105		87		29		11		18
3/6				169		156		51		14		13
3/7				66		55		25		14		11
3/8				65		48		60		14		17
3/9				43		31		24		7		12
3/10				89		65		66		8		24
3/11				15		9		5		1		6
3/12				3		0		2		2		3
3/13				87		60		33		10		27
3/14				145		114		72		9		31
3/15				127		96		49		10		31
3/16				130		113		48		17		17
3/17				126		104		45		11		22
3/18		1300		23		18		9		0		5
				1193		956		518		128		237
3/19-3/22 C/												
3/22	1500			70		54		20		11		16
3/23				68		45		16		13		23
3/24				108		87		29		12		21
3/25				51		44		13		17		7
3/26				105		81		21		22		24
3/27				63		50		18		19		13
3/28		1400		34		27		6		10		7
				499		388		123		104		111
3/28-4/2 D/												
4/2	0900			5		2		4		0		3
4/3				17		12		8		1		5
4/4				56		41		19		6		15
4/5		1300		51		41		33		2		10
				129		96		96		9		33
4/5-5/1 E/												
SPECIES			CHS	STS	CHS	STS	CHS	STS	CHS	STS	CHS	STS
5/2	1200		611	1	516	0	299	0	23	0	95	1
5/3			1044	17	872	15	433	9	53	0	172	2
5/4									23			0
5/5			[illegible]	0	[illegible]	0	[illegible]	0	26	0	[illegible]	0
5/6		1000	272	0	222	0	220	0	4	0	50	0
			3915	18	3275	15	1980	9	129	0	640	3
5/6-5/11 F/												
5/12	0000		253	0	189	0	250	0	9	0	64	0
5/13			175	0	131	0	104	0	1	0	44	0
5/14				1	86		75	0	2	0	21	1
5/15			[illegible]	0	112	8	98	0	5	0	23	0
5/16								0		0		0
5/17			[illegible]	0	[illegible]	0	[illegible]	0	[illegible]	0	13	0
5/18			76	0	73	0	51	0		0	3	0
5/19			255	0	192	0	79	0	22	0	63	0
5/20								0	56	0		0
5/21			[illegible]	0	[illegible]	0	[illegible]	0	20	0	[illegible]	0
5/22		2400	354	0	354	0	143	0	36	0	0	0
			2446	1	2058	0	1182	0	178	0	388	1
5/23-5/30 F/												
5/31	0000		645	0	556	0	233	0	19	0	89	0
6/1								0	8	0		0
6/2			[illegible]	0	[illegible]	0	[illegible]	0	12	0	[illegible]	0
6/3						0		0		0		
6/4		0900	[illegible]	0	[illegible]	0	[illegible]	0	[illegible]	0	[illegible]	8
			1551	0	1293	0	562	0	57	0	258	0
6/4-6/21 F/												

A/ STS = steelhead CHS = spring chinook salmon
B/ Time-Lapse VCR malfunction.
C/ Video Recording equipment stolen.
D/ Video equipment removed while block plate installed on viewing room door.
E/ Time-lapse VCR malfunction - sent in for repairs.
F/ Tapes not reviewed yet.

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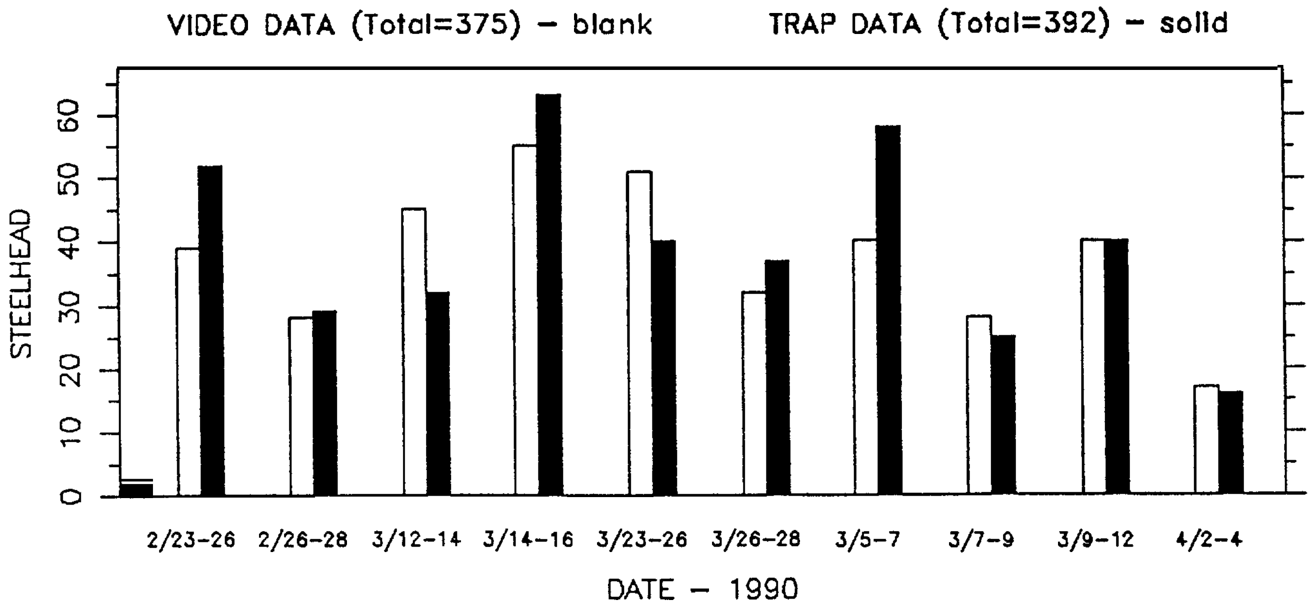

Figure B-9. Enumeration data of steelhead as measured with video tape recordings compared to trap counts, Three Mile Falls Dam, east bank, February through April 1990.

Table B-4. **Summary** of steelhead video tape and trap data during periods of simultaneous operations, Threemile Falls Dam, east bank, 1990.

VIDEO TAPES					TRAP DATA		
DATE	**HOUR**	**# UP**	**# DOWN**	**# UP MINUS # DOWN**	**DATE**	**HOUR**	**#**
2/23	1200	41	35	6	2/23	1200	
2/24		115	87	28			
2/25		26	20	6	to		
2/26	0900	9	10	-1	2/26	1200	
		191	152	39			52
2/26	1000	54	38	16	2/26 to	1200	
2/27		65	58	7			
2/28	0900	15	10	5	2/28	1200	
		134	106	28			29
3/5	1200	92	67	25	3/5 to	1200	
3/6		169	156	13			
3/7	0900	43	41	2	3/7	1200	
		304	264	40			58
3/7	1000	23	14	9	3/7 to	1200	
3/8		65	48	17			
3/9	0900	10	8	2	3/9	1200	
		98	70	28			25
3/9	1000	33	23	10	3/9	1200	
3/10		89	65	24			
3/11		15	9	6	to		
3/12	0900	0	0	0	3/12	1200	
		137	97	40			40
3/12	1000	3	0	3	3/12 to	1200	
3/13		87	60	27			
3/14	0900	72	57	15	3/14	1200	
		162	117	45			32
3/14	1000	73	57	16	3/14 to	1200	
3/15		127	96	31			
3/16	0900	65	57	8	3/16	1200	
		265	210	55			63
		34		11			
3/23	1200	108	23 87	21	3/23	1200	
3/24		51	44	7	to		
3/25							
3/26	0900	52	40	12	3/26	1200	
		245	194	51			40
3/26	1000	53	41	13	3/26 to	1200	
3/27		63					
3/28	0900	34	27	7	3/28	1200	
		150	118	32			37
4/2	1200	14	12	5	4/2 to	1200	
4/3							
4/4	0900	25	15	10	4/4	1200	
		46	29	17			16

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when the video equipment and trap were operated simultaneously, a total of total of 1,124 spring chinook salmon were counted on the video tapes and 926 were trapped (Figure B-10, Table B-5). The video equipment counted 21% more fish than we trapped. If the period of extreme disparity between video counts and trap counts (May 18 through 21) is eliminated, the video counts total 959 spring chinook salmon, and the trap counts were 926 fish. Thus, the video equipment counted 5% more fish than were trapped.

Comparisons of visual and video count data showed some differences. On May 3, the window watch resulted in 55 spring chinook passing upstream and 47 passing downstream, versus 54 up and 49 down observed on the tape. Therefore, the net number of fish recorded was eight during the window watch and five reviewing the tape. On May 10 and both the window watch and the video tape review ended up with seven spring chinook passing upstream and eight passing downstream for a net "loss" of one fish.

Visual observations of fish abundances below Three Mile Falls Dam were noted and were compared to the trap counts. During periods of high fish numbers in the trap, relatively large numbers of fish were observed in the ladder and pools below the ladder entrance. During periods of low fish numbers in the trap, few fish were observed in the ladder and lower pools (Appendix B-2).

DISCUSSION

As observed in 1987 and 1988, significant numbers of redds and spawning and dead fall chinook salmon and coho salmon were observed below the dam in 1989. These observations raise concerns about possible passage impediments in the lower Umatilla River, but these concerns were not evaluated as part of this project. Prespawn mortality of these fish did not appear to be a serious problem (9%). It is unclear whether these fish experienced passage obstructions at Three Mile Falls Dam, in the passage channels below the dam, or were spawning in the lower river for other reasons (eg.I where they had been released). If any of these fish had migrated up through the east bank fish ladder at Three Mile Falls Dam, and through the V-trap located at the last ladder baffle, then it is unlikely that they would have fallen back through the dam's passage facility. We recommend that a continued evaluation of passage through the river below the dam.be implemented in order to determine if the notable numbers of salmon spawning below the dam is a product of passage problems.

The video recording techniques used at Three Mile Falls Dam in 1989 and 1990 recorded passage of adult salmon through the viewing area of the dam, and elucidated some aspects of the passage of these fish that may lead to further improvement of the facility. The equipment recorded clear pictures of fish during the majority of flows and turbidities. However, when turbidity became severe (secchi disk depths less than approximately 0.25 m), some fish that

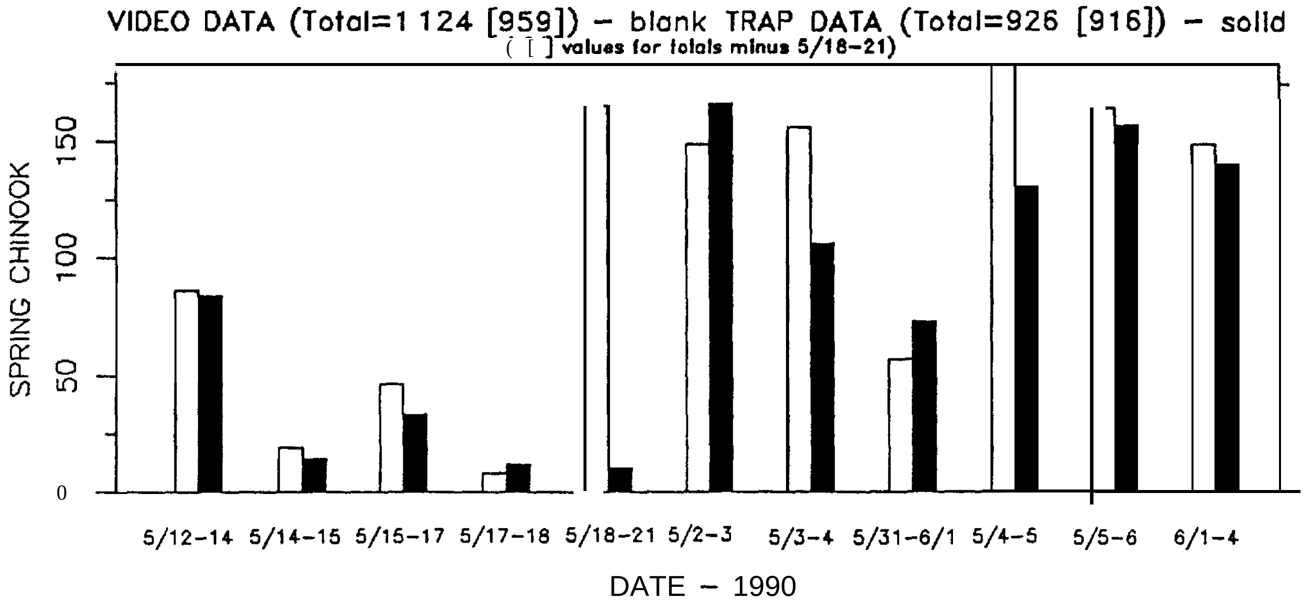

Figure B-10. Enumeration data of spring chinook salmon as measured with video tape recordings compared to trap counts, Three Mile Falls Dam, east bank, May through June 1990.

Table B-5. **Summary** of spring chinook salmon video tape and trap data during **periods** of simultaneous **operations, Threemile** Falls Dam, east bank, 1990.

VIDEO TAPES					TRAP DATA		
DATE	**HOUR**	**# UP**	**# DOWN**	**# UP MINUS # DOWN**	**DATE**	**HOUR**	**#**
5/2	1200						
5/3	1200	965	816	149	5/3	1200	166
5/3	1200						
5/4	1200	1051	895	1%	5/4	1200	106
5/4	1200						
5/5	1200	1094	923	171	5/5	1200	131
5/5	1200						
5/6	1200	805	641	164	5/6	1200	157
5/12	1200		168	55	5/12	1200	
5/13		223			to		
5/14	1200	154	123	31	5/14	1200	
		377	291	86			84
5/14	1200						
5/15	1200	65	46	19	5/15	1200	14
5/15	1200		179	22	5/15	1200	
5/16		201			to		
5/17	1200	154	130	24	5/17	1200	
		355		46			33
5/17	1200						
5/18	1200	86	78	8	5/18	1200	12
5/18	1200				5/18	1200	
5/19		126	122				
5/20		463	348	11:		to	
5/21	1200	396	350	4 4	5/21	1200	
		985	820	165			10
5/31	1200				5/31 to	1200	
6/1	1200	531	474	57	6/1	1200	73
6/1	1200				6/1 to	1200	
6/4	1000	689	540	149	6/4	1200	140

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passed the viewing window towards the backlight chamber would not receive any illumination from the fluorescent shop lamps and became faintly silhouetted blurs. Large gaps in the data are present (only 30% of the total fish passage period is on tape) because of a TLVCR malfunction that required shipping and bench time of one month, and security breaches that resulted in a stolen system and down time while improvements to door locks were performed. Several security improvements were implemented and others are planned for the near future.

Reviewing the tapes proved much more time consuming than anticipated, primarily due to the amount of back and forth movement displayed by the fish. Of the tapes reviewed to date, 24,299 observations of salmon movement through the viewing area have been made for a total of 1,795 fish past the window. Therefore, only 7% of the fish movement recorded actually resulted in fish passing the viewing area. This problem, and the additional amount of time required to review tapes, has prevented recording jack-to-adult ratios, fin clip information, and sex ratios. We recorded four different variables for each species of salmon (upstream past the window, downstream past the window, up into the window then back down, and down into the window then back up). In order to accurately record the other biological information, from eight to 20 permutations of the biological parameters could potentially be recorded for each salmon that completely passed the window (not including the fish that exit the viewing area from the same direction they entered). For fall chinook salmon, there are 20 possible permutations (ad-clip/no ad-clip, upstream/downstream, male/female, jack/adult/subjack - the jacks and subjacks would not be sexed). For spring chinook salmon, there would probably only be eight permutations because sex ratios are extremely difficult to measure. Through the use of large multiple unit tally meters, combined with experienced gained through time, this information may be achievable in the future.

We hypothesize that the back and forth activity occurs when fish that have passed through the last baffle of the fish ladder and through the V-trap grate are prevented from passing into the forebay through the fishway exit and hold in the viewing area while trying to pass into the Denil steep pass. Velocities at the window on April 6, 1990 were one f/s on the bottom, 3.25 f/s on the surface, and from 1.5 to 2.5 f/s throughout the rest of the profile. At the mouth of the steep pass, there is an eddy at the bottom of the channel, flows are consistently about 0.5 to 0.75 f/s throughout the rest of the profile, and at the surface are 1.5 f/s. Therefore, only the surface flows at the entrance to the steep pass are comparable to those flows at the viewing window. The flows at the bottdm of the channel, where the majority of salmon where observed with the video tapes, are backwards at the mouth of the steep pass. Questions arise as to the effectiveness of the fish passage facility with respect to adult salmon passing from the ladder into the steep pass. The salmon at this point have passed the facility though, and we hypothesize that the amount of back and forth movement would be greatly decreased if the fish were allowed to freely swim onward out the fishway exit. We have proposed to test this hypothesis next year.

The east bank trap data does not reflect daily arrivals into the trap (except when the trap was emptied daily). Therefore, the trap data may slightly lag behind when the fish actually passed the dam because the fish may have been in the trap for' several days before the trap was emptied.

During the periods when the video recording equipment and the holding trap were operated simultaneously, the video counts were within plus or minus 5% of the trap counts. This comparison is somewhat subjective. Individual periods when the trap was emptied were compared to enumerations based on the video recordings. If the trap was cleared on day one at 1200 hours, then cleared again on day three at 1200 hours, then the video enumerations from 1200 hours on day one through 0900 hours on day three were used in the comparison. The "cutoff time" of the video enumerations was selected to be slightly earlier than when the trap was checked because of the back and forth movement displayed by the fish. Over several consecutive days of these tallies, most of the error associated with the start and end times of tape enumerations is probably canceled. The considerable deviation between the trap and video counts observed with spring chinook salmon on May 18-21 is perplexing (165 video, 10 trapped). Subsequent reviews of three different one-hour periods (May 20, 0200 to 0300 and 1200 to 1300 hours; and May 21, 100 to 1100 hours) resulted in similar counts (11 versus 12 fish). The tapes display moderate video quality (clear water and good lighting). On these dates the fish were trapped in the ladder between the V-trap grate and the fishway lead gate by dropping the ladder water to approximately 1.5 feet and hand netting the fish. Perhaps some fish escaped through the V-trap grate as the water was lowered, but it is very difficult to comprehend 155 fish doing so. Several individual video observations of the spring chinook salmon displayed only one field of a fish (versus the typical three to five fields). Perhaps many fish were not recorded passing down past the window because the fish passed during the 0.6 second that the tape was not recording. We propose to compare taping at 24 and 72-hour modes simultaneously in 1990-91 to determine if the 72-hour mode that was used for this report is adequate for all species.

Several one hour segments of recorded tape were reviewed three times by the same reader, and the error rate within those readings occasionally reached 5%. We propose to further test tape reading precision in future years. After several seasons of verifying the accuracy of the tape information as compared to the trap data, and quantifying the variability of tape counts between and within reviewers, a coefficient may be developed to adjust differences between the counts.

The number of salmon counted during an hour of sitting in the viewing room versus the video recording was identical when few fish were present (May 10 - a net "loss" of one fish). However during a period of peak migration **(May 3),** eight fish were recorded passing the window from the viewing room versus five in the video tape (55 **"window-watch"** and 54 **"video"** passing upstream, and 47 **"window-watch"** and 49 **"video"** passing downstream). The **window-**watch process was awkward due to tallying multiple fish with pencil on paper and could have resulted in missing some fish. We did not have the multiple unit tally meters during these periods, and using the meters will greatly enhance the window-watch process in the future.

We plan to continue the passage evaluation of adult salmon at Three Mile Falls Dam during the 1990-91 migration. The evaluation will continue to use the methods developed this year, and will also further investigate the quantity of back-and-forth movement, and attempt to determine if the back-and-forth movement results in delays or injuries that may be improved.

Appendix B-l. Threemile Falls Dam Trap Data - Right Bank, 1989-1990.

DATE	MEAN[A/] DAILY FLOW (cfs)	MEAN DAILY TEMPERATURE (Degrees C)	SECCHI DISK (M)	COHO[B/]	FALL[C/] CHINOOK	SUMMER STEELHEAD	SPRING' CHINOOK
4Oct89	49	14.0		9	1	0	0
9Oct89	195	15.0		163	52	21	0
11Oct89	181	14.8		52	28	4	0
13Oct89	208	13.9		178	36	5	0
16Oct89	222	11.7		62	25	7	0
18Oct89	218	11.1	1.2	8	3	1	0
20Oct89	245	12.5	1.0	24	6	6	0
23Oct89	258	12.9	1.2	47	78	8	0
25Oct89	248	11.8	1.1	198	16	4	0
27Oct89	170	11.4	1.2	1046	100	40	0
30Oct89	166	9.2	1.5	147	51	22	0
3Nov89	157	8.7	1.2	30	14	4	0
6Nov89	153	10.1	1.3	196	39	8	0
9Nov89	157	10.8	1.2	481	36	9	0
13Nov89	184	11.2	1.1	1357	101	19	0
17Nov89	197	8.5	1.1	211	5	9	0
22Nov89	118	9.8	1.1	121	9	11	0
1Dec89	100	6.9	1.1	65	0	5	0
8Dec89	114	9.0	1.6	130	0	4	0
15Dec89	98	4.9	1.8	35	1	0	0
29Dec89	95	6.2	1.7	6	0	2	0
5Jan90	92	7.3	1.5	2	0	0	0
10Jan90	622	8.1	0.4	53	1	62	0
12Jan90	662	5.8	0.5	0	0	70	0
16Jan90	451	6.5	1.0	1	0	131	0
17Jan90	400	6.2	0.9	1	0	181	0
24Jan90	134	5.4	0.9	0	0	27	0
31Jan90	107	6.2	1.2	0	0	13	0
5Feb90	93	6.3	1.2	0	0	7	0
13Feb90	991	3.2	0.4	0	0	29	0
20Feb90	311	2.3	1.0	0	0	25	0
23Feb90	460	7.8	0.8	0	0	79	0
26Feb90	1090	6.7	0.5	0	0	52	0
28Feb90	860	5.7	0.5	0	0	29	0
5Mar90	616	8.1	0.9	0	0	62	0
7Mar90	686	8.0	0.7	0	0	58	0
9Mar90	852	8.7	0.7	0	0	25	0
12Mar90	1310	7.7	0.3	0	0	40	0
14Mar90	894	7.5	0.5	0	0	32	0
16Mar90	636	8.8	0.5	0	0	63	0
19Mar90	742	12.4	0.7	0	0	53	0
21Mar90	1430	10.2	0.5	0	0	40	0
23Mar90	1230	8.6	0.5	0	0	54	0
26Mar90	696	8.4	0.9	0	0	40	0
28Mar90	434	10.3	0.8	0	0	37	0
30Mar90	269	11.5	0.8	0	0	39	0

Appendix B-l (continued).

DATE	MEAN[A/] DAILY FLOW (cfs)	MEAN DAILY TEMPERATURE (Decrees C)	SECCHI DISK (M)	COHO[B/]	FALL[C/] CHINOOK	SUMMER STEELHEAD	SPRING[B/] CHINOOK
2Apr90	387	14.2	0.7	0	0	24	0
4Apr90	532	12.7	0.8	0	0	16	0
6Apr90	380	12.8	0.9	0	0	21	0
9Apr90	301	12.1	0.9	0	0	34	1
11Apr90	96	13.3	1.3	0	0	16	2
13Apr90	97	14.4	1.0	0	0	3	0
16Apr90	70	17.7	1.4	0	0	4	1
18Apr90	48	17.2	1.6[D/]	0	0	3	1
19Apr90	24	16.6	1.7[D/]	0	0	0	0
20Apr90	20	17.5	1.8[D/]	0	0	0	0
24Apr90	70	15.2	1.8[D/]	0	0	7	1
27Apr90	140	12.2	1.0[D/]	0	0	25	16
30Apr90	1920	9.9	0.4[D/]	0	0	36	57
1May90	1870	11.3	0.4	0	0	10	109
2May90	1890	12.8	0.4	0	0	12	113
3May90	1960	13.2	0.4	0	0	5	166
4May90	1740	13.9	0.4	0	0	3	106
5May90	1370	15.1	0.48'	0	0	0	131
6May90	1040	14.2	0.5[D/]	0	0	0	157
7May90	727	12.4	0.7	0	0	6	118
8May90	501	11.9	0.7[D/]	0	0	3	106
9May90	450[D/]	13.6	0.72'	0	0	0	116
10May90	331	14.9	0.7	0	0	1	87
12May90	203	14.8	0.8	0	0	0	116
14May90	130	14.3	0.6	0	0	2	168
15May90	83	14.7	1.1	0	0	0	14
17May90	200[E/]	16.9	0.9	0	0	0	33
18May90	200[E/]	16.4	0.8	0	0	0	12
21May90	350[E/]	17.8	1.3	0	0	0	10
25May90	500[E/]	16.0	1.29'	0	0	0	30
28May90	750[E/]	16.5	1.12'	0	0	0	87
29May90	1500[E/]	16.4	1.1	0	0	0	16
31May90	1200	14.4	0.5[D/]	0	0	0	111
1Jun90	1380	13.0	0.3	0	0	0	73
4Jun90	876	15.0	0.7	0	0	0	140
8Jun90	498	16.7	0.2	0	0	0	48
11Jun90	341	16.8	0.5[D/]	0	0	0	23
13Jun90	266	16.3	1.3	0	0	0	7
15Jun90	154	19.1	1.4	0	0	0	8
19Jun90	43	20.8	1.0	0	0	0	4

[A/] USGS Umatilla Gage - Provisional Data (9/4/90).
[B/] Coho and spring chinook totals include adults and jacks.
[C/] Fall chinook totals include adults, jacks, and subjacks.
[D/] Interpolated data.
[E/] Visual observation data (Sue Knapp, ODFW, personal communication).
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Appendix B-2. Visual observation notes for Three Mile Falls Dam Adult Passage Evaluation - October through December 15, 1989.

October 19 - Snorkeled and walked the pools directly below the dam and saw no fish. From October 18 to 20, a total of 50 salmon were captured in the east bank trap.

October 23 - No fish seen in the pool below the east bank ladder, yet approximately 300 salmon were captured in the trap.

October 24 - Saw six salmon jump into the pool directly below the east bank ladder in five minutes, and saw eight pass the viewing window in five minutes. On October 25, approximately 600 salmon were captured in the trap.

November 6 - Saw six salmon in the pool directly below the west bank ladder, and another below the east bank ladder. From November 3 to November 11, four angler surveys were conducted below Three Mile Falls Dam (funded by the general fisheries management program). Live salmon were reported seen by anglers and were also observed by the surveyors during this time period. For example, on November 10, an angler reported seeing 50 to 100 salmon move through the head of the dynamited channel 900 feet below the dam in five hours. The surveyor saw eight salmon move through the same area in 15 minutes. These observations **preceeded** the most active trapping period from November 9 through 13, when approximately 2,000 salmon were captured in the east bank trap.

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